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TRANSCRIPT OF RECORD.

SUPREME COURT OF THE UNITED STATES,

OCTOBER TERM, 1883.

No. 231.

CHARLES N. BLACK, ADMINISTRATOR OF MOSES THOMPSON, DECEASED, AND ELIZA W. FITZGERALD, ADMINISTRATRIX OF WILLIAM P. N. FITZGERALD, DECEASED, APPELLANTS,

vs.

SAMUEL THORNE, JONATHAN THORNE, JUNIOR, AND JAMES McFARLANE.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK.

FILED MARCH 18, 1881.

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1 The President of the United States of America to Samuel Thorne, James McFarlane, and Jonathan Thorne, greeting:

You are hereby commanded that you, and each of you, personally appear before the judges of the Circuit Court of the United States of America for the southern district of New York, in the Second Circuit Court, in equity, on the first Monday of October, A. D. 1869, wherever the said court shall then be, to answer a bill of complaint exhibited against you in the said court by Charles N. Black & al., and to do further and receive what the said court shall have considered in that behalf. And this you are not to omit under the penalty on you of two hundred and fifty dollars.

Witness Hon. Salmon P. Chase, Chief Justice of the Supreme Court of the United States, at the city of New York, on the 11th day of September, in the year one thousand eight hundred and sixty, and of the Independence of the United States of America the ninety-fourth.

(Signed) KENNETH G. WHITE,
Clerk.

CHARLES N. BLACK,
Compl'ts Sol'r.

The defendants are required to enter appearance in the above cause in the clerk's office of this court on or before the first Monday of October, 1869, or the bill will be taken *pro confesso* against them.

K. G. W., *Clerk.*

2 [Endorsed:] Personally served on the within-named defendants; Francis C. Barlow, U. S. marshal; Sept. 14th; filed Sept. 20, '69.

3 IN EQUITY.

To the Honorable the Justices of the United States Circuit Court for the southern district of New York, sitting in equity:

Charles N. Black, as he is administrator of the estate of Moses Thompson, late of Boston, in the county of Suffolk and commonwealth of Massachusetts, deceased, intestate, as citizen of the state of New York, for the southern district of New York, and Eliza W. Fitzgerald, as she is the administratrix of William P. N. Fitzgerald, late a citizen of the city, county, and state of New York, deceased, intestate, against Samuel Thorne, James McFarlane, and Jonathan Thorne, jr., all of the city, county, and state of New York, copartners in business under the firm name and style of Thorne, McFarlane & Co., and within the southern district of New York.

And therefore your orators complain and show that heretofore, and before the 10th day of April, A. D. one thousand eight hundred and fifty-five, said Moses Thompson, being then a citizen of the United States, was the original and first inventor and discoverer of

certain new and useful improvements in burning wet fuels; that being such inventor, said Moses Thompson made application
4 in writing to the Commissioner of Patents of the United States for the granting of letters patent of said improvements, and duly swore to the specification for that purpose. That said improvements were not, nor was either of them, at the time of said application, on public use or on sale with the consent or allowance of the said Moses Thompson, as the inventor or discoverer thereof, contrary to the provisions of the statutes in such cases made and provided, nor was not, nor was either of them, known or used prior to the invention of the said Moses Thompson.

That the said Moses Thompson duly complied in all respects with all the necessary conditions and requirements of the statutes of the United States in such cases made and provided prior to the granting of the letters patent hereinafter mentioned.

That on the 10th day of April, A. D. 1855, letters patent of the United States, bearing date of that day, were issued to the said Moses Thompson, his heirs, administrators, or assigns, for the full term of fourteen years from the said 10th day of April, A. D. 1855, for the full and exclusive right and liberty of making, constructing, using, and vending to others to be used the said invention or improvements, a description whereof was given in the words of the said Moses Thompson in the schedule annexed to said letters patent, and was made part of the same.

That letters patent were issued in the name of the United States of America, and were sealed with the seal of the Patent Office of the United States, and were signed by the Secretary of the Interior, and were countersigned by the Commissioner of Patents, and were issued and delivered to the said Moses Thompson.

That before said Moses Thompson obtained said letters patent, he did, in accordance with the requirements of the statute in that behalf, deliver to the Commissioner of Patents of the United States a written description of said inventions and the manner and proof of making, constructing, and using the same, and specified and pointed
5 out the part, improvement, or combination which he, the said Moses Thompson, claimed as his invention or discovery, and did accompany said description with drawings of said invention or improvements, which said description was signed and sworn to by said Moses Thompson and attested by two witnesses, and filed in the Patent Office.

And your orators further show that a copy of said letters patent, and the schedule annexed thereto, as aforesaid, are annexed hereto, marked "A," and which your orators pray may be deemed and taken a part of this their bill, and to the original of which, now in your orators' possession, and ready to be produced, they crave leave to refer.

And your orators further show that heretofore, and on the 7th day of October, A. D. 1856, the said Moses Thompson was advised by his said counsel and verily believed the said letters patent were inoperative,

by reason of a defective or insufficient description or specification; and such defect or error having arisen through inadvertence, accident, or mistake, without the fraudulent or deceptive intention on the part of the said Moses Thompson, said letters patent were surrendered by the said Moses Thompson on said 7th day of October, A. D. 1856, to the Commissioner of Patents, who thereupon accepted such surrender, and issued unto said Moses Thompson a new patent for the same invention for the residue of the period then unexpired for which the original letters patent were granted, to wit, for the term of fourteen years from the said 10th day of April, A. D. 1855, the date of the original letters patent, and that said reissued letters patent were made in accordance with a corrected and amended description in writing, made by the said Moses Thompson, and filed in the office of said Commissioner of Patents. That on the 7th day of October, A. D. 1856, said reissued letters patent, bearing date of that day, were issued to said Moses Thompson, according to law, whereby there was granted to the said Moses Thompson, his heirs, administrators,
6 or assigns, for the term of fourteen years from the said 10th day of April, A. D. 1855, the date of the original letters patent, the full and exclusive right and liberty of making, constructing, using, and of vending to others to be used the invention and improvement aforesaid, a corrected and amended description and specification whereof was given in the words of said Moses Thompson in the written schedule annexed to said reissued letters patent, and was made part of the same; that letters patent were issued in the name of the United States of America, and were sealed with the seal of Patent Office of the United States, and were signed by the Secretary of the Interior, and were countersigned by the Commissioner of Patents, and were issued and delivered to the said Moses Thompson. That before said Moses Thompson obtained said letters patent, he did, in accordance with the requirements of the statutes in that behalf, deliver to the Commissioner of Patents of the United States a corrected and amended written description of said invention, and of the manner and process of making, constructing, and using the same, and specified and pointed out the part, improvement or combination which he, the said Moses Thompson, claimed as his invention or discovery, and did accompany said description with drawings of said invention or improvement, which said description was signed and sworn to by the said Moses Thompson and attested by two witnesses, and filed in the Patent Office.

And your orators further show unto your honors that heretofore, and on the 31st day of March, A. D. 1857, the said Moses Thompson was advised by his counsel, and verily believed to be true, that said letters patent, to wit, those bearing date the 7th day of October, A. D. 1856, were inoperative, by reason of defective or insufficient description or specification, and such defect or error having arisen through inadvertence, accident or mistake, without any fraudulent or deceptive intention on the part of the said Moses Thompson, said

letters patent, to wit, those bearing date A. D. 1856, were
7 surrendered by the said Moses Thompson on said 31st day of March, A. D. 1857, to the Commissioner of Patents, who thereupon accepted of such surrender, and issued unto said Moses Thompson a new patent for said invention, for the residue of the period then unexpired for which the original letters patent were granted, to wit, for the term of fourteen years from the said 10th day of April, A. D. 1855, the date of the original letters patent; and that the said last reissued letters patent bearing date of that day were issued to the said Moses Thompson, his heirs, administrators or assigns, for the term of fourteen years from the said 10th day of April, 1855, the date of the original letters patent, the full and exclusive right and liberty of making, constructing, and using, and of vending to others to be used, the inventions and improvements aforesaid, a corrected and amended description and specification whereof was given in the words of the said Moses Thompson in the schedule annexed to said last reissued letters patent, and was made part of the same.

That said last reissued letters patent were issued in name of the United States of America, and were sealed with the seal of the Patent Office of the United States of America, and were signed by the Secretary of the Interior, and were countersigned by the Commissioner of Patents aforesaid, and were duly issued and delivered to the said Moses Thompson.

That before said Moses Thompson obtained said letters patent last mentioned, he did, in accordance with the statutes in that behalf, deliver to the Commissioner of Patents aforesaid a corrected and amended written description of said invention and improvements, and of the manner and process of making, constructing, and using the same, and specified and pointed out the part, improvement or combination which he, the said Moses Thompson, claimed as his invention or discovery, and did accompany said description with drawings of the said invention or improvement, which said de-
8 scription was signed and sworn to by the said Moses Thompson and attested by two witnesses and filed in the Patent Office.

And your orators further show that heretofore, and before the 15th day of December, A. D. 1857, said Moses Thompson, being a citizen of the United States, was the original and first inventor of certain new and useful improvements in Begasse furnaces; that being such inventor and discoverer, said Moses Thompson made application in writing to the Commissioner of Patents of the United States for the granting of letters patent for said improvement, and duly swore to the specification for that purpose; that said inventions were not, nor were either of them, at the time of said application, on public use or on sale, with the consent or allowance of said Moses Thompson, as the inventor or discoverer thereof, contrary to the provisions of the statutes of the United States in such cases made and provided, and was not, nor was either of them, known or used anterior to the invention or discovery thereof by the said Moses

Thompson. That the said Moses Thompson duly complied in all respects with all the necessary requirements of the statutes of the United States in such cases made and provided prior to the granting of the letters patent hereinafter mentioned.

That on the said 15th day of December, A. D. 1857, letters patent of the United States, bearing date of that day, were issued to the said Moses Thompson, according to law, whereby there was granted and secured to the said Moses Thompson, his heirs, administrators or assigns, for the term of fourteen years from the said 15th day of December, 1857, the full and exclusive right and privilege of making, constructing, using, and vending to others to be used the inventions and improvements aforesaid, a description where was given, in the words of the said Moses Thompson, in the schedule annexed to said letters patent, and was made part thereof.

That said letters patent were issued in the name of the United States of America, and were sealed with the seal of the Patent
9 Office of the United States, and were signed by the Secretary of the Interior, and countersigned by the Commissioner of Patents of the United States, and were duly witnessed and delivered to the said Moses Thompson.

That before said Moses Thompson obtained said letters patent he did, in accordance with the statutes in that behalf, deliver to the Commissioner of Patents aforesaid a written description of said invention, and of the manner and process of making, constructing, and using the same, and specified and pointed out the part, combination, or improvement which he, the said Moses Thompson, claimed as his inventions, or improvements, or discovery, and did accompany said description with drawings of the said inventions or improvements. That said description was signed and sworn to by the said Moses Thompson, and attested by two witnesses and filed in the Patent Office.

And your orators further show unto your honors that a copy of said letters patent, and of the schedule annexed thereto as aforesaid, are hereunto annexed and marked "C," and which your orators pray may be deemed and taken as a part of this their bill, and to the original of which, now in your orators' possession and ready in court to be produced, they crave leave to refer.

And your orators further show unto your honors that the said Moses Thompson, during his lifetime, did, by an instrument in writing under his hand, sell, transfer, assign, and convey, for a good and valuable consideration, to William P. N. Fitzgerald, on the 19th day of December, A. D. 1857, one undivided fifth part of said letters patent in, to, and for the states of New York, New Jersey, and Pennsylvania; that said deed of conveyance was received and recorded in the Patent Office of the United States March 10th, 1858; that the original is now in your orators' possession, ready in court to be produced, and which your orators pray may be deemed and taken as part of this their bill.

And your orators further show unto your honors that here-
10 tofore, and on the 2nd day of August, A. D. 1869, Charles N. Black, one of your orators, was duly appointed administrator of the estate of the said Moses Thompson, late of Boston, in the county of Suffolk, in the commonwealth of Massachusetts, deceased, intestate, by letters of administration issued under the seal of the Surrogate's Court in the city of Brooklyn, in and for the county of Kings and state of New York aforesaid, on the said 2d day of August, A. D. 1869, and that he gave bonds to the acceptance of said surrogate for the faithful performance of his trust according to law in that behalf. That a certificate of his appointment as administrator was issued by and under the seal of said Surrogate's Court on the 2d day of August, A. D. 1869, a copy of which is hereto annexed, and which your orators pray may be deemed and taken as part of this their bill, and to the original of which, now in your orators' possession and ready in court to be produced, they crave to refer.

And your orators further show unto your honors that heretofore, and on the 28th day of September, A. D. 1867, Eliza W. Fitzgerald, one of your orators, was duly appointed administratrix of the estate of William P. N. Fitzgerald, late of the city, county, and state of New York, deceased, intestate, by letters of administration issued by and under the seal of the Surrogate's Court, in and for the city and county and state of New York aforesaid, on the 28th day of September, A. D. 1867, and that she gave bonds to the acceptance of said surrogate for the faithful performance of her trust according to law in that behalf, and in all respects duly complied with all the requirements of the law in that behalf.

That a certificate of her appointment as administratrix aforesaid was issued by and under the seal of the said Surrogate's Court on the 28th day of September, A. D. 1867. That a copy of said letters of administration are hereto annexed, and which your orators pray may be deemed and taken as a part of this their bill, and to the original of which, now in your orators' possession, they crave leave to refer.

11 And your orators further show unto your honors that Aaron Woodman, of the city, county, and state of New York, was formerly, and prior to the appointment of C. N. Black, one of your orators, administrator of the estate of the said Moses Thompson, having been so appointed according to law; that, as such administrator, he petitioned the Commissioner of Patents of the United States of America, in accordance with the statutes of the United States in that behalf made and provided, for the renewal of the patent granted to the said Moses Thompson April 10th, 1855, reissued October 7, 1856, and reissued again March 31st, 1857; and that the said Commissioner of Patents did thereupon, in accordance with the power vested in him by the statutes of the United States, on the 8th day of April, A. D. 1869, extend and renew the said patent for the term of seven years from and after the said 10th day of April, A. D. 1869, and that the said patent has now the same effect in law as though the same had been

granted originally for the term of twenty-one years; that the said renewed and extended patent was sealed with the seal of the Patent Office of the United States and signed by the Commissioner of Patents, and recorded in the Patent Office, and duly delivered to the said Aaron Woodman, as administrator aforesaid.

And your orators further show unto your honors that Aaron Woodman resigned his trust as administrator of the estate of said Moses Thompson, and Charles N. Black appointed such administrator, as hereinbefore set forth.

And your orators further show to your honors that Charles N. Black, one of your orators, in and by virtue of his appointment as administrator of the estate of the said Moses Thompson as aforesaid, is now entitled to all rights, interest, and privileges secured and granted to Aaron Woodman as administrator of the said estate of Moses Thompson, as aforesaid, in and to the extension and renewal of said letters patent, as hereinbefore set forth.

12 And your orators further show that in and by virtue of the appointment of Charles N. Black as administrator of the estate of the said Moses Thompson, and in and by virtue of the appointment of the said Eliza W. Fitzgerald as the administratrix of the estate of the said William P. N. Fitzgerald, they became, were, and are now entitled to have, demand, and recover all goods, rights, chattels, and claims for damages due and accruing to the said Moses Thompson and William P. N. Fitzgerald during their lifetime, and to the estates of the said Moses Thompson and William P. N. Fitzgerald since their decease, and that the said Moses Thompson and William P. N. Fitzgerald, in their lifetime, were, and that your orators, Charles N. Black, as administrator of the estate of said Moses Thompson, and your orator, Eliza W. Fitzgerald, as administratrix of the estate of said William P. N. Fitzgerald, are now entitled to all the rights, interests, and privileges secured and granted to the said Moses Thompson, his heirs, administrators, or assigns, in and to said inventions and improvements, in and for the said states of New York, New Jersey, and Pennsylvania.

And your orators further show to your honors that said inventions and improvements so patented as aforesaid are, and each of them is, of great value, importance, and utility; and that the same are capable of being used in furnaces for burning wet fuels to very great advantage, and that the same been extensively introduced into public use, and that the public have generally acquiesced in the rights of the said Moses Thompson and of the said William P. N. Fitzgerald, and of your orators as administrator and administratrix as aforesaid, for the states of N. York, N. Jersey, and Pennsylvania aforesaid, in and to the said inventions and improvements; and that the said Moses Thompson and the said William P. N. Fitzgerald would in their lifetime, and your orators as administrator and administratrix aforesaid would, but for the unlawful and wrongful acts and doings of the said defendants, and others acting in con-

13 cert with them, have made large gains and profits from the manufacture and sale or said inventions and improvements.

And your orators further show unto your honors, upon information and belief, that the said defendants made, constructed and used, or caused to be made, constructed, and used, and that the said defendants are now using one of said furnaces, so constructed and made as aforesaid, at the town of Laporte, in the county of Sullivan, in the state of Pennsylvania; and one of said furnaces at Albion, in the county of Oswego, in the state of New York; and one of said furnaces at some place or town in the state of New York or Pennsylvania, but at what particular place or town is at present to your orators unknown.

And that the said defendants, Samuel Thorne, James McFarlane, and Jonathan Thorne, jr., doing business in the city, county, and state of New York, and within the southern district of New York, well knowing the premises, rights, and privileges secured unto the said Moses Thompson in his lifetime, and of William P. N. Fitzgerald as part owner, as hereinbefore set forth, and of your orators as administrator and administratrix, as heretofore set forth, but contriving to injure the said Moses Thompson and the said William P. N. Fitzgerald in their lifetime, and your orators as administrator and administratrix as aforesaid, and to deprive them of the advantages, benefits, and profits which might, and otherwise would, have accrued to them at Laporte, in the county of Sullivan, and Albion, in the county of Oswego, both in the state of New York, and at some other town or place in the state of New York or Pennsylvania, but at what particular place or town is at present to your orators unknown, and without the license and permission of, and against the will of, the said Moses Thompson and William P. N. Fitzgerald, in their lifetime, and license or permission, and against the will of your orators in their capacities atoresaid, the said defendants have ever since the unlawfully and wrongly
14 made, constructed, and used, or caused to be made, constructed, and used, furnaces containing said inventions and improvements, and in violation of and infringing upon the exclusive rights secured to the said Moses Thompson in his lifetime; and the said defendants, in the litetime of the said Moses Thompson and William P. N. Fitzgerald, did derive and receive, and since their deaths have derived and received, and are still deriving and receiving from such unlawful making, construction, and use, great gains and profits, but to what amount your orators cannot with exactness set forth.

But your orators believe the same to be nine thousand dollars, and so charge the fact to be, and pray that the said defendants may be required to make disclosure of all such gains and profits; and your orators in like manner aver that the defendants, though requested by the said Moses Thompson and William P. N. Fitzgerald in their lifetime, and by your orators in their several capacities aforesaid, to desist from such unlawful making, construction, and use, and to pay the said Moses Thompson and William P. N. Fitzgerald in their lifetime, and to your orators in their said several capacities as

aforesaid, all such gains and profits as they, the said defendants, have actually made; but the said defendants have wholly neglected and refused so to do.

By means whereof the said Moses Thompson and William P. N. Fitzgerald in their lifetime, and your orators in their several capacities as administrator and administratrix as aforesaid, have been greatly injured—deprived and prevented from recovering the gains and the profits to which the said Moses Thompson and the said William P. N. Fitzgerald in their lifetime, and your orators in their capacities aforesaid, are now entitled from the exclusive rights and privileges so granted and secured as aforesaid. And which the said Moses Thompson and the said William P. N. Fitzgerald in their lifetime, and your orators in their several capacities as aforesaid, would have received but for the said wrongful acts of the said defendants.

15 And that the said defendants, their attorney, solicitors, clerks, servants, agents, and workmen may be perpetually enjoined and restrained, by a decree of this court, from directly or indirectly making, or causing to be made, or using, or causing to be used, in any manner, any furnace containing or embracing said inventions or improvements, or either of them, or of any substantial or material part thereof, or infringing upon or violating said letters patent, by the use or sale of said improvements in any way whatsoever, and that said defendants may be decreed to account as aforesaid, and to pay the costs of this suit, and that your orators may have such other and further relief as the equity of the case may require and as to your honors may seem fit.

To the end, therefore, that the defendants may, if they can, show cause why your orators should not have the relief hereby prayed, and may full, true, and perfect answers make, according to the best of their knowledge, remembrance, information, and belief, to the matters hereinbefore set forth, as fully and particularly as if the same were here repeated and they specially interrogated—

May it please your honors to grant to your orators a writ of subpœna, directed to Samuel Thorne, James McFarlane, and Jonathan Thorne, jr., commanding them to appear and make answer to this bill of complaint, and to perform and abide by such order and decree herein as to the court may seem required by the principles of equity and good conscience.

And your orators will ever pray.

CHAS. N. BLACK,
Solicitor for Complainants.

UNITED STATES OF AMERICA, }
Southern District of New York, } *ss.*

On this 11th day of Sept., A. D. 1869, personally appeared before me Charles N. Black, administrator of the estate of Moses Thompson, one of the complainants herein, who, upon being duly sworn,

upon oath deposes and says that all and singular the allegations of the foregoing bill are true of his own knowledge, except so far as they are set forth on information and belief, and such matters he verily believes to be true.

CHAS. N. BLACK.

Sworn before me this 11th day of September, A. D. 1869.

J. V. FRENCH,
Notary Public, City & Co. New York.

[Endorsed:] U. S. Circuit Court. Chas. N. Black, adm'r, &c., agst. Samuel Thorne et als. Bill of complaint. Chs. N. Black, solr. for compl't. Filed Sept. 11, 1869.

16 [Blank page.]

17 United States Circuit Court, southern district of New York.

CHARLES N. BLACK, administrator, &c., of the estate of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, administratrix of the estate of WILLIAM P. N. FITZGERALD, deceased,
vs.
SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, jr. } In Equity.

The joint and several amended answer of Samuel Thorne, James McFarlane, and Jonathan Thorne, jr., the above-named defendants, to the bill of complaint of Charles N. Black, as administrator of the estate of Moses Thompson, deceased, and Eliza W. Fitzgerald, as administratrix of the estate of William P. N. Fitzgerald, deceased, the above-named complainants.

These repliants, now and at all times hereafter saving and reserving unto themselves all and all manner of benefit and advantage of exception to the manifold errors and insufficiencies in the said bill of complaint contained, for answer thereto, or unto so much thereof as they are advised it is material or necessary to make answer unto, answering, say:

That they admit that one Moses Thompson did on the 10th day of April, 1855, obtain letters patent of the United States for an alleged new and useful improvement in burning wet fuels, but on information and belief deny that the said Thompson was the original and first inventor of said alleged improvement, or that the same was not known or used prior to the alleged invention thereof by the said Thompson.

That they admit that the said Moses Thompson, on the 7th day of October, 1856, surrendered said letters patent to the Com-
18 missioner of Patents, and that there was issued to said Moses Thompson a new patent; but these defendants deny that said original letters patent were inoperative by reason of a defective or

insufficient description or specification, and state, as they are advised and believe, that said original letters patent were improperly and wrongfully surrendered.

That they admit that the said Moses Thompson, on the 31st of March, A. D. 1857, surrendered said reissued letters patent to the Commissioner of Patents, and that there was issued a new patent; but these defendants deny that said reissued letters patent so surrendered were inoperative by reason of a defective or insufficient description or specification, and allege on information and belief that the said reissued letters patent were surrendered, and new ones obtained by said Thompson, for the purpose of further including therein, and did include therein, more than he did originally contemplate, specify, or show to be his alleged invention on the application for his original patent, and which he had no right to include and claim in such last-mentioned reissue; and they further allege that the said reissued letters patent were not surrendered to correct any mistake therein or insufficiency thereof, but to claim other and different inventions and things; and they deny that the last-mentioned reissued letters patent are for the same alleged invention as the original letters patent of April 10, 1855, and allege that they are for inventions and things substantially and ma erially different.

And these defendants, further answering, on information and belief allege that the things patented in said last-mentioned reissued letters patent, and every substantial and material part thereof claimed as new, were anterior to the supposed or any discovery or invention thereof, or of any substantial or material part thereof, by the said Thompson, known to and publicly used by divers persons in this country, and among such persons who had such prior knowledge, and who used the same as aforesaid, and the places where the same were so known and used, are as follows:

Thomas B. Peddie, John Morrison, Samuel H. Burritt, Joseph L. Hewes, John M. Phillips, and D. B. Crockett, all at the city of Newark, state of New Jersey, and elsewhere in said state of New Jersey, and all now residing in said city of Newark; M. M. Schultz,
19 at said city of Newark, and elsewhere in said state of New Jersey; also at Sparrowbush, in the town of Deer Park, in Orange county, state of New York, and elsewhere in said state of New York, now residing in Wilcox, Elk county, state of Pennsylvania; Jackson S. Schultz, at said city of Newark, and elsewhere in said state of New Jersey, and at said Sparrowbush, in said town of Deer Park, and elsewhere in said state of New York, and now residing in the city of New York, state of New York; William Hoyt and Oliver Hoyt, both at said city of Newark, and elsewhere in said state of New Jersey, and both now residing in Stamford, state of Connecticut; Hans Rees, at said city of Newark, and elsewhere in said state of New Jersey, and at Woodstock, in Ulster county, state of New York, and elsewhere in the state of New York, now residing in said city of New York; Joseph B. Hoyt, at said city of Newark, and elsewhere in the state of New Jersey; also at said Woodstock, and

elsewhere in the state of New York, now residing at said Stamford; William H. Little, Joseph Jacobs, and Henry Poor, all at South Danvers, state of Massachusetts, and all now residing in said South Danvers; Joseph Frye, at Salem, state of Massachusetts, now residing in said Salem; Alvin Devereaux and George Sornburger, both at Deposit, state of New York, and both now residing in said Deposit; Judson Schultz, at Homowack, Ulster county, state of New York, and elsewhere in said state of New York, and now residing in Leurenkill, Ulster county, state of New York.

And these defendants, further answering, say that the alleged things patented, and every substantial and material part thereof claimed as new by the said letters patent, were, anterior to the supposed or any discovery or invention thereof, or of any substantial or material part thereof, by the said Moses Thompson, described in the following named printed public works, that is to say:

Tredgold on the Steam Engine: "The Steam Engine, its invention and an investigation of its principles for navigation, manufacturing, and railways," by Thomas Tredgold, C. E., etc., London; John Weale, Architectural Library, No. 59 High Holborn, 1838, in plates 33, 34, and 35 of part II, and in description on pages 361 and 362 of volume I; also in plate 42 of volume II, and in description on page 361 of volume I.

Also in printed book commonly known as Peclet de la Chaleur, second edition, and entitled "Traite de la Chaleur consideree dans ses applications," par E. Peclet, deuxieme edition, tome seconde, Paris, Libraire de L Hackette, Rue Pierre Sarazin 12, 1843, on pages 130 and 131, and in paragraph 1325 therein; also, in plate 63, figures 1 to 5 inclusive, referred to in said paragraph; also, on pages 271 and 272, and in paragraph 1665 therein; also, in plate 93, figures 1 to 5 inclusive; and in paragraphs 625 to 627 inclusive of vol. 1, and plates and figures therein referred to; also, at page 275, section 669 and 670.

Also, in printed book commonly known as Karsten's Science of the Manufacture of Salt, entitled "Lehrbach der Salinenkunde, von Dr. C. J. B. Karsten," Berlin, G Reimer, 1847, in pages 661 and 662 of volume second. Also, on pages 688 and 689, and on plate 3 of same volume of said work; also, pages 609, 621, and 622 of part 6 of said work.

Also, in printed publication commonly known as "Karsten's System de Metallurgie," by Dr. J. C. B. Karsten, Berlin, 1831, G. Reimer, 3d volume, page 363; also in same work, figures 741 and 742 on plate 34, at pages 479 to 481 inclusive.

Also in printed publication commonly known as the London Journal of Arts and Sciences, conjoined series, in volume 20, commencing on page 432, and in figure 3 of the plates; and in volume 40, commencing on page 264; also on pages 189 to 191, inclusive, of volume 22, and on page 209 of volume 17 of said work.

Also in printed publication commonly known as "Tagbuch Einer

Metallurgischer Reise, &c.," by Hollander, 1824, at page 373; also at pages 464, 468, 414 and 87.

Also in printed publication commonly known as "Dingler's Polytechnic Journal," volume 195, plate 8, figures 21, 22, and 23.

Also in printed publication commonly known as "Fuhror des Maschinisten," by E. F. Scholl, Braunschweig, Friedrich Biewig & Son, 1845, on pages 58 and 59, at paragraph 59.

And in the following named patents, that is to say, in—

Letters patent granted in Great Britain, in the year 1875, to
21 James Watt, for furnaces and fire-places, and numbered 1845.

Letters patent granted in Great Britain, in the year 1835, to John Chanter and John Gray, for furnaces of steam boilers, and numbered 6920.

Letters patent granted in Great Britain, in the year 1837, to John Chanter and John Gray, for furnaces of locomotive engines, and numbered 7306.

Letters patent granted in Great Britain, in the year 1848, to Richard Rodda, for furnaces, fire-places and stoves, and numbered 7765.

Letters patent granted in Great Britain, in the year 1848, to John Juckes, for steam-engine boilers and apparatus for feeding and promoting combustion in furnaces and fire-places, and numbered 7858.

Letters patent granted in Great Britain, in the year 1839, to Thomas Hall, for furnaces of steam-engine boilers, &c., and numbered 7974.

Letters patent granted in Great Britain, in the year 1840, to Samuel Howard, for boilers and furnaces, and numbered 8600.

Letters patent granted in Great Britain, in the year 1846, to Thomas Murgatroyd Dean, for furnaces of steam and other boilers, and numbered 11,109.

Letters patent granted in Great Britain, in the year 1851, to Edwin Rose, for boilers for generating steam, and numbered 13,615.

Letters patent granted in Great Britain, in the year 1851, to John Hicks, for steam boilers, and numbered 13,691.

Letters patent granted in Great Britain, in the year 1852, to William Beckett Johnson, for railway turntables, steam boilers, &c., and numbered 13,959.

Letters patent granted in Great Britain, in the year 1853, to James Bristow and Henry Attwood, for consuming smoke, and numbered 1049.

Letters patent granted in Great Britain, in the year 1855, to John Lee Stevens, for steam boilers, and numbered 1807.

Letters patent granted in Great Britain, in the year 1840, to Thomas Farmer, for heating pyrites and other matters to obtain sulphur, &c., and numbered 8398.

Letters patent granted in the United States, on the 15th day of August, 1848, to Spencer Hungerford, for improvements in boiler furnaces, and numbered 5712.

22 Letters patent granted in the United States, on the 6th day of May, 1856, to Hagar and Allyn, for improvements in Bagasse furnaces, and numbered 14,812.

And these defendants, further answering, say that they are informed and believe, and therefore allege, that the first claim of the last mentioned reissue is an invalid one, because it is indefinite and equivocal, and does not refer to the process specified and described in the language of the specification preceding said claim, and these defendants pray the judgment of this honorable court thereon.

And the defendants, further answering, admit that said Moses Thompson did, on the 15th day of December, A. D. 1857, obtain letters patent of the United States, for alleged new and useful improvements in Bagasse furnaces, but on information and belief, deny that said Thompson was the original and first inventor thereof, or that the same were not or either of them known or used anterior to the alleged invention thereof by the said Thompson.

And these defendants, further answering, on information and belief, allege that the things patented in said letters patent, and every substantial and material part thereof claimed as new, were, anterior to the supposed or any discovery or invention thereof, or of any material part thereof, by the said Thompson, known to and publicly used by divers persons in this country, and among such persons who had such prior knowledge, and who used the same as aforesaid, and the places where the same were so known and used are as follows: Thomas B. Peddie, John Morrison, Samuel H. Burrett, Joseph L. Hewes, John M. Phillips, and D. B. Crockett, all at the city of Newark, state of New Jersey, and elsewhere in said state of New Jersey, and all now residing in said city of Newark; M. M. Schultz, at said city of Newark, and elsewhere in said state of New Jersey; also at Sparrowbush, in the town of Deer Park, in Orange county, state of New York, and elsewhere in said state of New York, now residing in Wilcox, Elk county, state of Pennsylvania; Jackson S Schultz, at said city of Newark, and elsewhere in said state of New Jersey, and at said Sparrowbush, in said town of Deer Park, and elsewhere in said state of N. Y., and now residing in the city of N. Y., state of N. Y.;

23 Wm. Hoyt and Oliver Hoyt, both at said city of Newark, and elsewhere in said state of New Jersey, and both now residing in Stamford, state of Connecticut; Hans Rees, at said city of Newark, and elsewhere in said state of New Jersey, and at said Woodstock, in Ulster county, state of New York, and elsewhere in the state of New York, and now residing in said city of New York; Joseph B. Hoyt, at said city of Newark, and elsewhere in the state of New Jersey, also at said Woodstock, and elsewhere in the state of New York, and now residing at said Stamford; William H. Little, Joseph Jacobs, and Henry Poor, all at South Danvers, state of Massachusetts, and all now residing in said South Danvers; Joseph Frye, at Salem, state of Massachusetts, now residing in said Salem; Alvin Devereux and George Sornburger, both at Deposit, state of New York, and both now residing in said Deposit; Judson Schultz,

at Homowack, Ulster county, state of New York, and elsewhere in said state of New York, now residing in Leurenkill, Ulster county, state of New York.

And these defendants, further answering, say that the alleged things patented, and every substantial and material part thereof, claimed as new by the said letters patent, were, anterior to the supposed or any discovery or invention thereof, or of any substantial or material part thereof, by the said Moses Thompson, described in the following named printed public works, that is to say, in—

Tredgold on "The Steam Engine, its invention and an investigation of its principles for navigation, manufacture, and railways," by Thomas Tredgold, C. E., etc., London: John Weale, Architectural Library, No. 59 High Holborn, 1838, in plates 33, 34 and 35 of part II, and in description on pages 361 and 362 of volume I; also in plate 42 of volume II, and in description on page 468 of volume I.

And in printed book commonly known as Péclet de la Chaleur, second edition, and entitled "Traite de la Chaleur, consideree, dans ses applications," par E. Péclet, deuxieme edition, tome seconde. Paris, Libraire de L. Hackette, Rue Pierre Sarazin 12, 1843, on pages 130 and 151, and in paragraph 1,325 therein; also in plate 63, figures 1 to 5 inclusive, referred to in said paragraph; also on pages 271 and 272, and in paragraph 1,665 therein; also in plate 93, figures 1 to 5, inclusive; and in paragraphs 625 to 627, inclusive,
24 of volume I and plates and figures therein referred to; also at page 272, sections 669 and 670.

Also in printed book commonly known as Karnsten's Science of the Manufacture of Salt, entitled "Lehrbaeh der Salinenkunde, von Dr. C. J. B. Karsten," Berlin, G. Reimer, 1848, in pages 661 and 662 of volume second, and on plate 3 of same volume of said work. Also pages 609, 621 and 622 of part 6 of said work.

Alson in printed publication commonly known as Karsten's System der Metallurgie, by C. J. B. Karsten, Berlin, 1831, G. Reimer, 3d volume, pages 363; also in same work, figures 741 and 742 on plate 34, at pages 479 to 481, inclusive.

Also in printed publication commonly known as the London Journal of Arts and Sciences, conjoined series, in volume 21, commencing on page 432, and in figure 3 of the plates, and in volume 40, commencing on page 264, also on page 189 to 191, inclusive, of volume 22, and on page 209 of volume 17 of said work.

Also in printed publication commonly known as Tagbneh Einer Metallurgischer Reise, &c., by Holunder, 1824, at page 373, also at pages 464, 468, 184 and 87.

Also in printed publication commonly known as "Dingler's Polytechnic Journal," volume 195, plate 8, figures 21, 22 and 23.

Also in printed publication commonly known as "Fuhror des Maschinisten," by E. F. Scholl, Braunschweig, Friedrick Bieweg and Son, 1845, on pages 58 and 59, at paragraph 59.

And in the following named patents, that is to say, in—

Letters patent granted in Great Britain, in the year 1785, to James Watt, for furnaces and fire-places, and numbered 1485.

Letters patent granted in Great Britain, in the year 1835, to John Chanter and John Gray, for furnaces of steam boilers, and numbered 6920.

Letters patent granted in Great Britain, in the year 1837, to John Chanter and John Gray, for furnaces of locomotive engines, and numbered 7306.

Letters patent granted in Great Britain, in the year 1838, to Richard Rodda, for furnaces, fire-places and stoves, and numbered 7765.

Letters patent granted in Great Britain, in the year 1838, to John Jukes, for steam engine boilers and apparatus for feeding and promoting combustion in furnaces and fire-places, and numbered 7858.

Letters patent granted in Great Britain, in the year 1839, to Thomas Hall for furnaces, steam-engine boilers, &c., and numbered 7974.

Letters patent granted in Great Britain, in the year 1840, to Samuel Howard, for boilers and furnaces, and numbered 8600.

Letters patent granted in Great Britain, in the year 1846, to Thomas Murgatroyd Dean, for furnaces of steam and other boilers, and numbered 11,109.

Letters patent granted in Great Britain, in the year 1851, to Edwin Rose, for boilers for generating steam, and numbered 13,615.

Letters patent granted in Great Britain, in the year 1851, to John Hick, for steam boilers, and numbered 13,691.

Letters patent granted in Great Britain, in the year 1852, to William Beckett Johnson, for railway turntables, steam boilers, &c., and numbered 13,959.

Letters patent granted in Great Britain, in the year 1858, to James Bristow and Henry Attwood, for consuming smoke, and numbered 1049.

Letters patent granted in Great Britain, in the year 1855, to John Lee Stevens, for steam boilers, and numbered 1817.

Letters patent granted in Great Britain, in the year 1840, to Thomas Farmer, for treating pyrites and other matters to obtain sulphur, &c., and numbered 8398.

Letters patent granted in the United States, on the 15th day of August, 1848, to Spencer Hungerford, for improvements in boiler furnaces, and numbered 5712.

Letters patent granted in the United States, on the 6th day of May, 1856, to Hagar & Allyn, for improvement in Bagasse furnaces, and numbered 14,812.

And these defendants, further answering, say that they are not informed save by the bill of complaint and do not know whether the said Moses Thompson did by an instrument in writing under his hand sell, transfer, assign, or convey to William P. N. Fitzgerald one undivided fifth part of said letters patent in, to, and for the

states of New York, New Jersey, and Pennsylvania, as in the bill of complaint mentioned, or whether said deed was recorded as therein mentioned, and therefore leave the complainants to make such proof as they may be advised.

26 And these defendants, further answering, say that they are not informed save by said bill of complaint and do not know whether the complainant, Charles N. Black, was duly appointed administrator of the estate of said Moses Thompson, deceased, or that such subsequent proceedings were had thereon as are alleged in the bill of complaint, and therefore leave the complainants to make such proof of such matters as they may be advised.

And these defendants, further answering, say that they are not informed save by said bill of complaint and do not know whether the complainant, Eliza W. Fitzgerald, was duly appointed administratrix of the estate of Wm. P. N. Fitzgerald, deceased, or that such subsequent proceedings were had thereon, or that she duly complied with the requirements of the law in that behalf, as is alleged in the bill of complaint, and therefore leave the complainants to make such proof thereof as they may be advised.

And these defendants, further answering, say that they admit that said letters patent of April 10, 1855, as reissued October 7, 1856, and again reissued March 31, 1857, were extended for the term of seven years, as in the bill of complaint mentioned, but on information and belief allege that the said extension was obtained through misrepresentation and fraud, and that extended patent was, in consequence of such matters, improperly granted, and is invalid.

And these defendants, further answering, say that they are not informed save by said bill of complaint and do not know whether Aaron Woodman resigned his trust as administrator of the estate of said Moses Thompson, or that Charles N. Black was appointed such administrator, or is now entitled to all the alleged rights, interests, and privileges alleged to be secured and granted to the said Aaron Woodman, as in the bill of complaint mentioned, or that the said Black and Fitzgerald, complainants, became, by virtue of the alleged appointments, in the bill of complaint mentioned, were or are now entitled to have, demand, and recover all goods, rights, chattels, claims for damages due and accruing to the said Moses Thompson and W. P. N. Fitzgerald during their lifetime, and to their estates since their decease, or that the complainants are now entitled to all the alleged rights, interests, and privileges alleged to be secured and granted to the said Thompson, and therefore leave the complainants to make such proof thereof as they may be advised.

And these defendants, further answering, on information and belief deny that said alleged inventions or improvements, or any of them, are of great or any value, or importance or utility, or that the same have been extensively introduced into public use, or that the public have generally or at all acquiesced in the alleged rights

27 of said Moses Thompson, or of the complainants, or either of them, as in the bill of complaint mentioned, or that the said

William P. N. Fitzgerald, or that the complainants, or either of them, would, but for the alleged unlawful, wrongful, or any acts or doings of said defendants, have made large or any gains or profits from the manufacture or sale of said alleged inventions or improvements.

And these defendants, further answering, say that the said last-mentioned reissued and also the last-mentioned original letters patent describe old, well-known mechanisms or means as applicable to alleged, but not in fact, new uses, and that the application thereof to such alleged new uses is not patentable, and these defendants pray the judgment of this honorable court thereon.

And these defendants, further answering, deny that they have made, constructed, or used, or caused to be made, constructed, or used, or that they are now using one or any number of said furnaces constructed or made as in the bill referred to at the town of Laporte, or one or any number of said furnaces at Albion, or at any other place or places within the United States.

And these defendants, further answering, deny that they are now or have been making, constructing, or using, or causing to be made, constructed, or used, furnaces containing such alleged inventions or improvements, or any part thereof, or have been, or are now infringing upon the alleged exclusive or any rights alleged to have been secured to said Moses Thompson in his lifetime, and deny that in the lifetime of the said Moses Thompson or William P. N. Fitzgerald, or at any other time, they derived or received from any alleged making, construction, or use, as in the bill of complaint mentioned, great or any gains or profits, without this, that there is any other matter, cause, or thing in the complainants' said bill of complaint contained, material or necessary for them to make answer unto, and not herein and hereby well and sufficiently answered, confessed, traversed, and avoided or denied, is true to the knowledge and belief of these defendants; all of which matters and things these defendants are ready and willing to aver, maintain, and prove as this honorable court shall direct.

And these defendants pray to be hence dismissed, with their reasonable costs and charges in this behalf most wrongfully sustained.

SAM'L THORNE,
JAMES McFARLANE,
JONATHAN THORNE, JR.

COCHRANE & TODD,
Solicitors for Defendants.
ANDREW J. TODD,
Of Counsel.

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UNITED STATES OF AMERICA,
Southern District of New York, } ss.

On this 25th day of March, A. D. 1872, before me personally appeared Samuel Thorne, James McFarlane, and Jonathan Thorne,

jr., who, being by me duly sworn, each for himself did depose and say that he had read the foregoing answer by them subscribed, and knows the contents thereof, and that the same is true of his own knowledge, except as to those matters which are therein stated to be on information and belief, and as to those matters he believes it to be true.

SAM. TRO. SMITH,
Notary Public, New York County.

[Endorsed:] U. S. Circuit Court; in equity; Charles N. Black, adm'r. et al, *v.* Samuel Thorne et al.; amended answer; Cochrane & Todd, defendants' sol'rs, 37 Park Row, N. Y. city; filed March 26, 1872.

29 United States Circuit Court for the southern district of New York.

CHARLES N. BLACK, administrator of the estate of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, administratrix of the estate of WILLIAM P. N. FITZGERALD, deceased,

vs.

SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORN, JR.

In Equity.

The replication of Charles N. Black, administrator of the estate of Moses Thompson, deceased, and Eliza W. Fitzgerald, administratrix of the estate of William P. N. Fitzgerald, deceased, complainants, to the answer of the said defendants, Samuel Thorne, James McFarlane, and Jonathan Thorne, jr.

These repliants, saving, securing, and reserving to them-
30 selves now and at all times hereafter all and all manner of benefits and advantage of exception which may be had or taken to the manifold insufficiencies of the said answer, for replication thereto, say that they will aver, maintain, and prove their bill of complaint to be true, certain, and sufficient in the law to be answered unto, and that the said answer of the said defendants is uncertain, untrue, and insufficient to be replied unto by these repliants; without this, that any other matter or thing whatsoever in the said answer contained, material or effectual in the law to be replied unto, and not herein or hereby replied unto, confessed and avoided,
31 traversed or denied, is true; all which matters and things these repliants are and will be ready to aver, maintain, and prove as this honorable court shall direct, and humbly prays as in and by their bill they have already prayed.

Dated December 29, 1869.

CHAS. N. BLACK,
Solicitor for Complainants and of Counsel.

32 United States Circuit Court, southern district of New York.

CHARLES N. BLACK, adm'r, &c., and another
against
SAMUEL THORNE and others.

JAMES COUSINS, a brown colored man, being first duly sworn, and admonished to tell the truth, the whole truth, and nothing but the truth, deposes as follows to the interrogatories propounded to him, viz.:

Question No. 1, by the counsel for the plaintiff:

What is your name, age, residence, trade or occupation, and are you a colored man, and are you free, or a slave, and can you read or write?

Answer. James Cousins; about thirty-four; Richmond, Virginia; I am an engineer and a leather currier; I am a colored man; I was born free, and am free now; I can neither read nor write.

Q. No. 2, by same:

If you are employed at present in this city, state where you work, at what business you work, how long you have worked at the same place, and whose employ you have been, and are, at the same place?

A. At the Richmond tan yard, in this city, at engineering and currying, as engineer. I manage the furnace and engine. I have been there nine years the 8th of this coming January. My first employer was Mr. Solomon Marsh, till his death, a year ago
33 last March. My next employer was Jesse C. Jones. I am with him still.

Q. No. 3, by same:

Are you acquainted with Mr. Moses Thompson, the plaintiff in these suits, and the defendants, or any of them? (The names of the plaintiff and defendants in these suits being read by the commissioners to the witness, he answered as follows:)

A. I am acquainted with Mr. Thompson; I know not the defendants.

Q. No. 4, by same:

When and where did you first become acquainted with Mr. Thompson?

A. At the Richmond tannery in this city, about eight years ago.

Q. No. 5, by same:

Do you know anything of Mr. Thompson having built a furnace at that tannery, and if you do, when was that furnace built, and is it or not the same furnace which is still used at that tannery?

A. I do know of Mr. Thompson building a furnace at that tannery; it was built in the year 1853; I think it was in August, about; it is the same furnace that is still there; the same one I have had charge of from the time it was built to the present time.

Q. No. 6, by same:

What kind of fuel have you used in that furnace from the time it

was built until the present time, and if you use wood in it at any time, state particularly at what times you use it?

A. I generally use the wet tan bark, but for the commencement of fires I use wood, and that is the only time I do use it.

Q. No. 7, by same:

Does the fire in your furnace ever go out, so that you need to kindle it with wood, except when in consequence of not needing the fire or the use of the engine you allow it intentionally to go out, and how long do you at any one time recollect the fire having
34 been kept—and the steam kept up by the use of wet tan, without other fuel?

A. It never goes out unless I allow it intentionally to go out; about six months at a time, and then we stop to clean out the boilers.

Q. No. 8, by same:

After the furnace in question was built, did Mr. Thompson have occasion to repair and alter it, and if so describe the furnace as it was originally built, and what made it necessary to repair it, and what alterations were made in it?

A. He had occasion to repair and alter it; it was first built and covered with sheet iron—boiler iron; that lasted only two weeks; there were two furnaces; each furnace has two ash pits, and a grate over each ash pit; there is a chamber above the grating to hold the wet tan; the wet tan rests upon the grating; there is a door at the front of each ash pit for draft; right over the door of the ash pit there is a door into the wet tan chamber for cleaning the grate; this is in each one of the furnaces; on the top of each furnace there is two openings for feeding the wet tan upon the grate; each furnace had a flue, which led out in front of the furnace above the doors; these two flues led into the mingling flue, which leads the heat to the boiler; the mingling flues were along over the doors in front leading to the boiler; the mingling flue at the end near the boiler bent down about two feet, and discharged or delivered the heat right under the boiler; the furnace was built of brick; the grates, doors, and the linings of the feeding-holes were made of cast iron; the front end of the boiler was placed at the end of the mixing flue; the iron used for the covering of the furnace could not stand the heat, therefore it was taken away; then there was dividing walls in each furnace into two equal parts; upon these walls were turned arches for the roofing of the furnace; the dividing walls divided each of the flues into two equal parts; this alteration made four distinct furnaces
35 out of the two, as they were originally; the flues of all four leading into the same mingling flue; the mingling flue was not changed; dampers were not put into the flues when the change was made; the dampers, when shut, did not entirely close up the flues; I don't recollect any other alteration being made.

Q. No. 9, by same:

Who gave you instructions how to manage and tend this furnace, and what were these instructions, and how did you succeed in burning the wet tan and in making steam?

A. Mr. Thompson gave me the instructions; he told me to take charge of the furnace and to make my fires to a right degree, and in my first commencement to kindle it with wood, and then my wood burns an half an hour; then I puts in the wet tan; then I takes my other furnace and kindles it off with wood in the same manner; then I puts in the wet tan; then my fires is in good order; then I have only to keep them clear of ashes; I goes in to feed my furnaces with wet tan, one after the other; the wet tan made a good hot fire, and very bright; it makes a hotter fire than dry wood, and affords plenty of steam; it makes more steam than the same quantity of dry wood would make; when I am operating the furnace I keep the door of the ash pit about six inches open.

Q. No. 10, by same:

While the fire of dry fuel is burning in the furnace, and before you put in the wet tan, does smoke come out of the stack, and if so, does a good deal or a little come out? And after you have put in the wet tan, does the smoke continue to come out of the chimney, or does it stop coming out?

A. In the first case a good deal comes out; in the second case it stops coming out; when the smoke stops going out of the chimney, which is when I put in the wet tan; the smoke burns in the mingling flue before it gets to the boilers; then when it leaves the mingling flue it comes out in a white lightish blaze; then you will find it, after
36 leaving the ends of the boilers, a pale blue blaze; I can see it about twelve feet; it lies up close to the boiler; it is not at all flashy; it is a regular burning heat.

Q. No. 11, by same:

What kind of bark is your tan made of?

A. Black oak, and very often use Spanish oak—we never use hemlock bark; there is none about here.

Q. No. 12, by same:

Did any part of your mingling flue ever burn out so as to require repairs?

A. No, sir; it did not burn out.

Q. No. 13, by same:

Are the dampers in the flues of the furnaces which were put there when the furnaces were required, as you have stated, still there; if not, what has become of them, and when did they disappear?

A. They are burned down; they disappeared in about four weeks after they were put in; I took the pieces out; they were burned to a cinder.

Q. No. 14, by same:

While those dampers were fit for use, how did Mr. Thompson tell you to use to them, and did you use them?

A. When I filled my furnace with wet tan then I would shut the damper, as near as I could—then I would open the damper in the flue of the other furnace, and let that one remain shut—then I would shut the damper in the next one—then I would open the flue in the

first one—then I would fill the next furnace up with wet tan, and shut the damper.

Q. No. 15, by the same:

Did the furnace, after it was repaired and divided, as you have stated, work in substantially the same manner as it did before, or did it work differently, or produce a different effect, and did you tend it in a manner substantially the same, or different?

A. It worked better than it did before—it produced a better heat; I tended it the same.

37 Q. No. 16, by same:

When your furnace is in full operation, doing its regular work, how often do you feed it in the course of twenty-four hours, and when?

A. I feed it twice a day, in the morning and at one o'clock p. m.; at night I fills her up, and I have the fires in order for steam next morning; I shuts my dampers of my ash pits; then I shuts my damper on the chimney; then I opens my doors under the boilers, that is to let air in, that is to prevent from having too much steam; when I feed at one o'clock, I shut the damper at the ash pits and on the chimney, and go to dinner; the damper on the chimney does not shut tight—some of the bricks were knocked off.

Q. No. 17, by same:

During night, when the air is shut out from all the furnaces, and the damper in the chimney is closed, and the door under the boiler open, what is the condition of the heat in the mingling flue and under the boiler, and is there any smoke coming from the mingling chamber?

A. It is a very bright, nice looking heat in the mingling chamber—the fires are then all burning bright in the furnace, no smoke at all comes out of the mingling chamber—a little bright blaze, tipped with blue, comes out of the mingling chamber; the heat is sufficient to keep the steam up in the boiler through the night, so that we are ready to start in the morning.

Q. No. 18, by same:

What are the dimensions of the wet tan chambers in your furnace, and of the mixing flue?

A. The bottom of the wet tan chamber is four feet six inches long; the width is two feet ten inches; from the gratings to the crown is twenty-nine inches; the mixing flue is about eighteen inches in diameter.

Q. No. 19, by same:

Did you ever know a furnace like this of Mr. Thompson's, which you have described, or such a way of burning wet tan before Mr. Thompson built the furnace about which you have testified?

38 A. No, sir.

Q. No. 20, by same:

Have you any interest, direct or indirect, in any patent taken out by Moses Thompson, or in the results of any of the suits in which your deposition is to be used?

A. No, sir.

And further this deponent saith not.

his
JAMES + COUSINS.
mark.

Adjourned to meet at this office on to-morrow morning, the 31st day of August, 1858.

WM. S. WATSON,
U. S. Com.

AUGUST 31st, 1858.

Met pursuant to adjournment.

WILLIAM T. WINGFIELD, being first duly sworn, and admonished to tell the truth, the whole truth, and nothing but the truth, deposed as follows to the interrogatories propounded to him, viz.:

Question No. 1, by the counsel for the plaintiff:

Please state your age, residence, and occupation.

Answer. I am about forty years of age; residence, Richmond, Virginia; I am a brick mason.

Q. No. 3, by same:

Are you acquainted with Moses Thompson, the plaintiff in these suits, and are you acquainted with the defendants, or any of them, and if you are acquainted with said Thompson, state particularly when and where you became acquainted with him?

(After the names of the parties had been read over by the commissioner to the witness, the witness answered as follows:)

A. I am acquainted with Mr. Thompson; I am not ac-
39 quainted with any of the defendants; I became acquainted with Mr. Thompson in this city in the summer of 1853, at the Richmond tannery.

Q. No. 3, by the same:

Please state whether there was a furnace built at that tannery, and if there was, under whose direction and superintendence it was built, who executed the work, and what kind of fuel it was intended to burn, and what the furnace was intended to do, and when it was built.

A. There was a furnace built at that tannery, commenced in the latter part of July and finished the first part of August, 1853; it was built under the direction and superintendence of Mr. Thompson. I executed the masonry and built the furnace. It was intended to burn wet tan, and I have seen them hundreds of times burning wet tan. I lived in the immediate neighborhood of it from the building of it, and do still. The furnace was intended to work all the machinery; that is, to drive an engine for that purpose, and do all the heating and boiling for the tannery.

Q. No. 4, by same:

Please to state whether the wet tan burned well, or otherwise, in

this furnace, and how the furnace did the work required of it at the tannery.

A. The wet tan burned well; it made a tremendous hot fire; I have seen it frequently; it makes a hotter fire than wood would have made, as hot certainly. The furnace did all the work that was required of it perfectly. There was a heavy business done at the tannery up to Mr. Marsh's death.

Q. No. 5, by same:

As you lived in the immediate neighborhood of the tannery, please state whether the smoke from the tannery furnace, before the erection of the furnace you have spoken of, caused annoyance and complaint among the neighbors, and what was the fact in regard to smoke when this new furnace was in operation, from the time it was built down to the present time.

A. It did cause annoyance and complaint among the neighbors; I have never heard any complaint about smoke since the new furnace was in operation; there is in fact no smoke only when it is kindling, and not even then enough to annoy anybody.

Q. No. 6, by same:

Please describe the furnace in question as particularly as you can, and if it has undergone repairs or alterations since you first erected it, state what rendered the changes necessary when they were made, what they were, and who made them, and under whose directions they were made?

A. In the first instance it was covered with plate, or boiler iron, in an arch form; finding the heat was so great it melted that down. There were two furnaces, and two feeders to each of them; they were through the plate in the top of the furnace; there were two ash pits to each furnace; in front of each ash pit there is an opening for draft; each opening has a damper; that damper you can close or regulate as you choose; above each of the ash pits there is a grating; that grating is to hold up the wet tan; there is an arched chamber over the grating to hold the wet tan; each chamber has a flue coming out in front, discharging into a flue running the whole length of both furnaces, called the mingling flue; these furnaces stand side by side, divided by a partition wall; the mingling flue in front led to the boiler, dipping about two feet at the end next the boiler, discharging under the end of the boiler; the stack is at the other end of the boiler, the damper at the top; there is a door in each of the wet tan chambers in front, under the mingling flue, for the purpose of cleaning the grate; the furnace has undergone alterations and repairs about two weeks from the time it was finished; the roofing melting down rendered repairs necessary, which were immediately made; I built a brick arch, covering all the furnaces; the feed openings were left in the same position, and the same number; there was a wall built in each furnace from front to rear, dividing of it into two equal parts; this wall continued right

41 up, and divided the flue into two equal parts; these walls made four chambers instead of two, and five flues instead of two, leading to the mingling flues, one from each of the newly-made chambers; to each of the flues I put a damper which would not entirely but partially close it; there were no other alterations or repairs except a few bricks put in near one of the feed holes, a few days ago; I don't recollect any others; I made all those alterations and repairs under the direction of Mr. Thompson, except the last.

Q. No. 7, by same:

Please state the dimensions of the chambers for the wet tan and the mingling flue as they were at first constructed, and also their dimensions after you had made the alterations.

A. The two old chambers were six foot four, by four foot six; from the grating to the crown was twenty nine inches; the mingling flue was sixteen inches in diameter; after the alterations the new chambers are two feet ten inches wide, four foot six inches long, and the same height they were before; no alterations whatever were made in the mingling flue; it has increased in diameter a little by burning.

Q. No. 8, by same:

Have you any interest in any patent taken out by Moses Thompson, or in the result of the suits, or either of them, in the trial of which this deposition is taken to be used?

A. No, sir; I have no interest whatever.

Q. No. 9, by same:

Are you acquainted with a colored man, residing in this city, named James Cousins; if so, how long have you been acquainted with him, and what is his character as a mechanic, and a man of honesty, truth, and intelligence in his business—is he a free man or a slave?

A. I have been acquainted with him twelve or fifteen years; he is considered a good mechanic and a good currier, and understands pretty much all the business about the yard; I consider him

42 a good engineer to run a stationary engine; he is considered so, and I consider him so; he is a first-rate engineer; he is so considered by those who know him; he is regarded as a man of honesty, truth, and intelligence; he has always been considered a free man; I have seen his free papers several times.

W. T. WINGFIELD.

JESSE C. JONES, being first duly sworn and admonished to tell the truth, the whole truth, and nothing but the truth, deposed as follows to the interrogatories propounded to him, viz.:

Question No. 1, by the counsel for the plaintiff:

Please state your age, residence, and occupation.

Answer. I am about forty-seven years of age; I reside in Richmond, Virginia; I am a tanner.

Q. No. 2, by same:

Please state whether you conduct business for yourself; and if yea, how long have you done so, and what tannery do you now occupy.

A. I do conduct business for myself, and have been for about seventeen years; I occupy what is termed the Richmond tannery.

Q. No. 3, by same:

How long have you occupied and worked that tannery; and if you purchased it, of whom did you purchase it, and what has become of the person who sold it to you?

A. I have worked by privilege from Mr. S. A. Marsh for a year and half, I think; after Mr. Marsh's death I bought the property from Mr. Frederick Brower; I have occupied the tannery partially and entirely for from three to four years; the person from whom I purchased it is now living in the city.

Q. No. 4, by same:

Who occupied this tannery before you took possession of it, and what has become of him?

A. Mr. Solomon A. Marsh occupied it; he is dead.

43 Q. No. 5, by same:

When you went to that yard, did you find a furnace there; and if so, what kind of fuel was burned in that furnace; and if the furnace was in use, for what purpose was it used in the tannery?

A. I did find a furnace there; wet spent tan bark was burned in it; the furnace was used to generate steam to drive the engine, pump up liquors out of the yard into the leaches, and for handling hides, and for milling hides, grinding bark, and conducting bark from the mill to the leaches; steam heating tub for making oil and for heating liquor.

Q. No. 6, by same:

Who did you find managing the furnace and engine when you came to the Richmond tan-yard, and who has continued to manage them till the present time?

A. I found James Cousins, a free colored man; the same man has continued to manage them to the present time; he is still in my employ.

Q. No. 7, by same:

Please state what is the character of James Cousins as a currier and an engineer, and as a man of honesty, veracity, and intelligence in his business.

A. I find him to be a very good currier and good engineer, as far as I am capable of judging, and an honest, upright man, and a man of veracity; I think he thoroughly understands the business which he pursues, which is running an engine and currying leather.

Q. No. 8, by same:

Please describe the furnace which you have in use at your tannery, and state whether it has been altered since you have been at the tannery.

A. The furnace outside consists of a brick wall; it is covered over with brick; under this covering are four arches; in each of those

arches there is a feed opening from the top to the grating; under the feed openings there are four chambers between the grate bars and arches; those chambers are separated by brick walls; below each grate there is an ash pit; there is an opening at the front of each ash pit, with a damper to each opening to regulate the draft; there is also a door to each chamber above the grating; those doors are for stirring up fire in the grating and shaking down the ashes; they are left closed at other times; there is a flue from each chamber into the main flue, which conducts the heat to the boilers; this main flue bends down a little below the bottom of the boiler, a little below the crown of the fuel chambers; the chambers above the grate are for holding the wet tan for burning; the stack is at the back end of the boiler, and the mingling flue at the other end; the stack has a damper at the top; there never has been any alteration since I have been at the tannery.

Q. No. 9, by same:

What is the general character of the operation of this furnace when wet tan alone is used, and does it or not perform all the work which is intended to perform at the tannery?

A. The furnace, in the first place, requires about the eighth of a cord of dry wood in the four chambers to start it, after which wet tan is all that is necessary to use to make the furnace perform all the duties it is intended to perform; it does its duty well.

Q. No. 10, by same:

How long will the fire in this furnace, after it is properly started, continue to do its work effectively if properly fed with wet tan alone?

A. It will be a perpetual motion, without some accident; I have known it to run two months at a time; I have never known it to stop, except when I choose to stop it.

Q. No. 11, by same:

As you have not stated all the appearances of the fire in your furnace, mingling flues, and under your boiler, please state whether you have given particular attention to these things yourself, or whether your furnace and engine have been to a very great extent managed by some one else without much of your personal attention?

A. It has been managed, without much of my personal attention, by James Cousins; I have seen the fire in the furnaces in the night, but I have not examined particularly the fires in the mingling flue or under the boiler.

Q. No. 12, by same:

From your experience in the use of your present furnace, please to state whether a cord of wet tan or a cord of good dry wood will produce the largest quantity of steam, the wet tan being burned in your furnace when in full operation, and the wood being burned by the best mode that of burning you are acquainted with.

A. It is my opinion the wet tan in my furnace will produce the most steam.

Q. No. 13, by same:

Have you any interest in any patent taken out by Moses Thompson, or in the result of the suits, or either of them, in the trial of which this deposition is taken to be used?

A. None at all.

And further this deponent saith not.

J. C. JONES.

UNITED STATES OF AMERICA.

NORTHERN DISTRICT OF NEW YORK, } ss.
County of Broome and State of New York, }

Be it remembered, that on this twentieth day of September, in the year of our Lord one thousand eight hundred and seventy, I, Charles S. Hall, a commissioner duly appointed by the Circuit Court of the United States for the northern district of New York, in the second circuit, under and by virtue of the acts of Congress entitled "An act for the more convenient taking of affidavits and bail in civil causes depending in the courts of the United States," passed
46 February 20th, 1812; and the act of Congress entitled "An act in addition to an act entitled 'An act for the more convenient taking of affidavits and bail in civil causes depending in the courts of the United States,'" passed March 1st, 1817; and the act entitled "An act to establish the judicial courts of the United States," passed September 24th, 1789, did call and cause to be and personally appear before me, at my office in the city of Binghamton, in the said northern district of New York, in the state aforesaid, James B. Weed, to testify and the truth to say, on the part and behalf of the plaintiffs, in a certain suit or matter of controversy now depending and undetermined in the Circuit Court of the United States for the southern district of New York, at the city of New York, in the district aforesaid, wherein Charles N. Black, as administrator of the estate of Moses Thompson, deceased, and Eliza W. Fitzgerald, as administratrix of the estate of William P. N. Fitzgerald, deceased, are plaintiffs, and Samuel Thorne, James McFarlane, and Jonathan Thorne, jr., are defendants; and the said James B. Weed, being about the age of thirty-three years, and having been by me first cautioned and sworn to testify the truth, the whole truth, and nothing but the truth in the matter of controversy aforesaid, I did carefully examine the said James B. Weed, and he did thereupon depose, testify, and say as follows, viz.:

I live in the city of Binghamton, and am engaged in the tanning and currying business.

Interrogatory 1. How long have you been engaged in this business?

Answer. From eighteen to twenty years.

Int. 2. At what place?

A. Binghamton, N. Y.

Int. 3. In what capacity have you been so engaged?

A. I have worked for my father and been in business for myself for the last ten years. My father's name was Marshal H. Weed.

Int. 4. Was he the owner of a tannery in his lifetime; and if so, where situated?

47 A. He was, at Binghamton.

Int. 5. Did you succeed him in business?

A. I did.

Int. 6. Was that an upper or sole leather tannery?

A. An upper leather tannery.

Int. 7. What kind of bark do you use in tanning?

A. Hemlock.

Int. 8. Did you know Moses Thompson in his lifetime?

A. I did. I became acquainted with him at Binghamton, in the summer or fall of 1854.

Int. 9. State the circumstances of your becoming acquainted with him, so far as you remember.

A. In 1854, when he came here, he hired out to my father as a currier.

Int. 10. Where did your father first meet him?

A. At Mr. Daniel B. Simpson's tannery, in Binghamton.

Int. 11. Did Moses Thompson build a furnace for your father at at any time, and if so, state when and where?

A. He built one at my father's tannery, in the fall of 1854, at Binghamton.

Int 12. Were you then working for your father at his tannery?

A. I was.

Int. 13. Describe how that furnace was constructed.

A. It had two ovens about four feet square, with a flue leading from each oven into a common flue or chamber, and this chamber discharging under the boiler. It had a door in the front of each oven, and also an ash pit, with door leading into it; the tan was fed through holes in the top; there was a feed hole in the top of each furnace; there was a separate ash pit for each oven; there were iron grate bars, and sufficiently wide apart to allow the charred tan to fall through; I don't recollect exactly, but I should judge about an half-inch apart.

47*a* Int. 30. What kind of fuel did you use in the furnace built by Thompson in 1854?

A. Spent tan, as it came from the leaches.

Int. 31. Did you dry it at all before using?

A. I did not.

Int. 32. After the furnace was built, in 1854, by Thompson, who first conducted the operation of feeding it at the commencement?

A. Thompson himself.

Int. 33. How did he conduct the operation?

A. He fed each oven alternately.

Int. 34. How did he start the fire in the beginning?

A. With dry fuel.

Int. 35. How much dry fuel did he use?

A. Enough to get the oven or furnace well heated up.

47b Int. 36. Having got the ovens well heated up, what was the next process adopted?

A. He then commenced feeding the tan through the feed holes, feeding each oven alternately.

Int. 37. In the beginning did he feed both furnaces at the same time, or did he feed one and then the other?

A. He usually fed one and then the other; I don't remember what he did in the beginning.

Int. 38. How did he regulate the ash-pit doors?

A. At the first feeding he kept them closed, and after they were well started let in a little air, but closed or nearly closed the most of the time?

Int. 39. Did you use any artificial blast or draft?

A. Only what was made by the stack.

Int. 40. Was this process of feeding kept up continuously after the fire was started?

A. It was.

Int. 41. Did you ever tend that furnace yourself?

A. I did.

Int. 42 For how long a period of time?

A. Pretty much all the time it was in existence.

Int. 43. What process did you adopt in feeding; any different from that you have described?

A. I adopted the same process.

Int. 44. In what condition was the ash pit of this furnace as to heat, when in operation?

A. We kept them as hot as the grates could bear; at a red heat usually.

Int. 45. How were they kept hot?

A. By the charred tan falling through and burning.

Int. 46. What did you use the heat for, produced by this furnace?

A. Used it for all purposes for which heat was needed, driving machinery and heating and running an engine about eight-horse power. The boiler was three feet diameter, two fourteen-inch flues through it, twenty feet long.

48 Int. 47. After starting the fire with dry fuel, as you have described, did you use any other dry fuel afterwards to keep it up?

A. We did not.

Int. 48. How long a period did you keep up the fire in this furnace with wet fuel without the use of any dry fuel?

A. I think for weeks at a time.

Int. 49. After this old furnace of 1854 was rebuilt, as you have described, how did you operate the second one with reference to starting the fire and feeding?

A. We operated that in the same manner as the first one.

Int. 62. What form do the heaps of tan thrown into the fire chamber exhibit, and what part of the heap appears to be on fire?

A. When first filled the tan presents a conical form, and the tan appears to burn from the outside, and as the heap burns down, little holes appear, which spread out gradually until all is consumed, unless it is refilled.

U. S. Circuit Court.

CHAS. N. BLACK, adm'r, &c.,
vs.
SAMUEL THORNE et al.

DANIEL B. SIMPSON, a witness on the part of the plaintiffs, being about the age of fifty-five years, and having been first cautioned and sworn to testify the truth, the whole truth, and nothing but the truth in the matter of controversy, did depose, testify, and say as follows, viz.: I reside in the city of Binghamton, N. Y., and am fifty-five years of age, and am a tanner and currier by trade.

Int. 1. Did you know Moses Thompson in his lifetime, and if so, when did you become acquainted with him?

A. I knew Mr. Thompson in his lifetime, and first became acquainted with him in 1836, at Haverhill, Mass.; we both worked in that *time* at our trade of currying.

Int. 2. Did you ever meet him in Binghamton, and when for the first time?

A. I did; in August, 1854.

Int. 3. Do you know anything of Thompson's having been employed to work for Marshal H. Weed; and if so, what?

A. He wanted to work for me, and I told him I had no work, but Mr. Weed was in want of a currier; he was employed by Mr. Weed at my suggestion at my shop.

49 Int. 4. Do you know anything about Mr. Thompson building a wet tan furnace for Mr. Weed; and if so, when?

A. In September or October, 1854.

Int. 5. After this furnace was built, were you employed by Mr. Thompson as his agent for building wet tan furnaces, such as he built at Mr. Weed's?

A. I was in the spring of 1855; he gave me a power of attorney, and went to New Orleans.

Int. 6. Did Thompson authorize you to sell rights under his patents for furnaces for burning wet tan?

A. He did.

Int. 7. Did you sell rights and construct furnaces under this power of attorney?

A. I did.

Int. 8. How long did you act as Thompson's agent in this matter?

A. Up to the time of his death.

Int. 9. Have you heard read the deposition of James B. Weed, taken before Charles S. Hall, U. S. commissioner, in this present suit, on the 20th and 21st days of September, 1870?

A. I have heard it read,

Int. 10. Are you personally acquainted with the facts stated in that deposition, as to the construction and operation of the several furnaces therein described; and if so, are the statements as therein made by Mr. Weed true to your knowledge?

A. They are.

Int. 11. And are you willing to adopt that statement as yours?

A. I am.

Cross-examination:

Cross-int. 12. Will you give us a list of the rights you sold, and what you got for each right?

(Objected to as immaterial.)

50 A. I will make out a list.

THURSDAY, *September* 22, 1870.

Pursuant to adjournment.

I here produce a list of the rights sold during the years 1856 and 1859; I have sold none since.

(List produced, marked "Exhibit Simpson.")

"*Exhibit Simpson.*"

Furnace rights sold to and paid for by—

Samuel Archibald, Oswego, N. Y.	$100 00
Samuel Stoddard, Ithaca, N. Y.	100 00
Howell, Curtis & Co., Cambelltown, N. Y.	150 00
J. D. Hamilton & Co., " "	150 00
J. Hand, A. Kiersted, Cadosia Valley, N. Y.	150 00
Fraser & Hongland, Callicoon, N. Y.	150 00
Danforth & Beekman, Taberg, N. Y.	150 00
Lewis Rider, Florence, N. Y.	100 00
Conrad Klein, Cortland, N. Y.	100 00
John & Wm. Pagett, Elmira, N. Y.	100 00
——— Bidwell, Berkshire, N. Y.	100 00
J. W. Brackney, Brackneyville, Pa.	100 00
Herring & Co., Lockhaven, Pa.	100 00
William Bates & Co., Syracuse, N. Y.	125 00
Wm. Tremain, Lanesboro, Pa.	75 00
Babcock, Gibbs & Co., New Berlin, N. Y.	150 00

51 U. S. Circuit Court, southern district of New York.

CHARLES N. BLACK, adm'r, &c., and ano'r,
against
SAMUEL THORNE and others.

JAMES TOMPKINS, a witness on the part of the plaintiffs, being about the age of fifty-seven years, and having been first cautioned

and sworn to testify the truth, the whole truth, and nothing but the truth in the matter of controversy aforesaid, did depose, testify, and say as follows, viz.:

I reside in Binghamton; I am now out of business; I am a millwright by trade.

Interrogatory 1. Have you built tanneries, and how many years were you engaged in the business?

Answer. I have built tanneries for eighteen years in this section of the country.

Int. 2. Were you ever in the tanning business yourself, and did you own a tannery, and if so, where?

A. I did, with a partner, at Liberty, Susquehanna county, Penn.; the tannery is now carried on by one Knight, the only owner I know of.

Int. 3. Were you ever at Marshal H. Weed's tannery at Binghamton, and if so, when?

A. I can't say when was the first time I was there; I was there when it was building, and have been there often since.

Int. 4. Did you ever go there to look at the wet-tan furnace, and when?

A. It was very soon after they got it in operation; I can't tell the exact date.

Int. 5. Did you examine the furnace when you went there?

A. I did.

Int. 6. Are you familiar with the manner of its construction and how it operated?

A. I don't know that I can remember every particular about it, except it was explained to me by Marshal H. Weed; I think there were four ovens—there might have been only two; they were built in the ordinary way, and discharged into what they called a mixing chamber; it is very little that I know of the operation; it was fed from the top; I don't remember how nor how often.

Int. 7. Have you ever built any furnaces for burning wet tan?

A. I have looked after the building of them—superintended them.

Int. 8. Have you ever seen the furnace at the Albion tannery?

52 A. I have.

Int. 9. When were you there and at what times?

A. I was there first April 6, 1864, and have been there several times since; I went there to meet Oliver Lapham.

53 Int. 22. Was this furnace in operation when you saw it on this occasion?

A. It was.

Int. 23. What kind of fuel did they use?

A. Wet tan.

Int. 24. State how they were operating these ovens when you saw them.

A. All except one were in full blast, and that was just filled.

Int. 25. How were the ash-pit doors placed?

A. All except the oven last filled were closed or nearly closed, and that one was a little open.

Int. 26. What kind of fire had they?

A. Very good, I should think.

Int. 27. From what you saw there can you tell how the furnaces were fed with wet tan?

A. The one last filled was commencing to burn. I do not know how to answer it any more than that as they burned down they filled them up.

Int. 28. Can you state in what rotation they were filled?

A. No; sometimes they cannot go in rotation.

Int. 29. For what reason?

A. The one filled may not burn as fast as one which has been filled since; one oven may be filled when the fire is low, or for some cause may not burn readily, so that one filled afterwards, in which the fire is just right, sets to burning sooner than the one filled first.

Int. 30. Where is the Albion furnace situated?

A. At Sand Bank.

Int. 31. Where did you first see awet tan furnace like this?

54 (Objected to as asking a conclusion, instead of asking for facts from which conclusions may be drawn.)

A. At Marshal H. Weed's tannery.

Int. 32. Did you observe the condition of the ash pits in this furnace?

A. They were hot, and in good order, and the grates were very hot.

Int. 33. Was there any fuel in the ash pit?

A. The hot tan which had dropped through the grate.

Int. 34. Will the fire burn successfully in ovens of this character when the ash pits are not hot?

55 A. I did. They called it that.

Cross-int. 40. Who called it that?

A. A man who was there around.

Cross-int. 41. Where did you see it?

A. At Newark, New Jersey.

Re-direct Examination:

Re-direct int. 49. What kind of a place did you find it located in?

56 A. In the boiler room of a tannery of patent leather, split leather, or both.

Re-direct int. 50. State what kind of a structure it was, as near as you can?

A. The oven was set up with a space from the foundation; the ash pits were under them; the oven was at the side of the boiler; they fed it through a door in front; this is about all I know of the oven; I don't know whether there was one or two ash pit doors.

Re-direct int. 51. Was it in operation?

A. Yes.

Re direct int. 52. What kind of fuel did they use?

A. Tan and coal.

Re-direct int. 3. How deep on the grate bars did they throw this tan and coal?

A. Not very deep; I could not tell how deep.

57 U. S. Circuit Court, southern district of New York.

CHARLES N. BLACK, adm'r, &c., an'r,
against
SAMUEL THORNE and others.

JOHN H. KIERSTED, a witness on the part of the plaintiffs, being about the age of sixty years, and having been first cautioned and sworn to testify the truth, the whole truth, and nothing but the truth, in the matter of controversy aforesaid, did depose, testify, and say as follows, viz: I reside at Hancock, Delaware county, New York; I am a tanner by trade.

Int. 1. Are you the owner of a tannery at that place?

A. Myself and brother own a tannery together there.

Int. 2. How many hides do you tan each year?

A. About twelve thousand hides, and sometimes more.

Int. 3. Have you a furnace there burning wet tan?

(Objected to as immaterial.)

A. I have.

Int. 4. Describe the construction of that furnace.

(Same objection.)

A. In the first place we have four ovens, about eight feet in length each and about four feet in width each. They are built with an ash pit underneath them, and then from the oven back they run into a chamber; two flues to each chamber. The flues of the
58 two outside ovens connect with the flues of the two inside ovens, and discharge through the flues of the inside ovens into the fire chamber; at the junction of the two flues there is a damper; there is a space under the boiler; I call the flue from the ovens, after the junction of the two flues, a fire chamber.

Int. 5. Is there any bridge wall behind this fire chamber?

(Objected to as immaterial.)

A. Yes; it is about five feet from the back of the boiler, and built to within five inches of the boiler.

Int. 6. When was this furnace built?

(Same objection.)

A. In 1856.

Int. 7. Have you a license for using it, and if so, from whom and when did you obtain it?

(Same objection.)

A. I believe we have a license from Moses Thompson, obtained when we put them in.

Int. 8. How do you feed the ovens?

(Same objection.)

A. We feed them from the top, and fill the back holes and front holes alternately; we feed the ovens alternately also, as well as the holes.

Int. 9. In what position do you keep the ash pit doors?

(Same objection.)

A. We keep them closed most of the time.

Int. 10. What kind of grate bars do you use?

59 (Same objection.)

A. They are made of fire brick.

Int. 11. Any fire in the ash pit, and how is that kept up?

(Same objection.)

A. Yes; It is kept up by the tan dropping through the grate bars; it forms a bed of coal there with the ashes.

Int. 12. Do you use any wood in these ovens?

A. Only when we clean out and start a new fire; then we usually put it in the ash pit.

Int. 13. How often do you clean out?

A. Once a week, and we may not as often; we clean only one oven at a time.

Int. 14. If you used dry fuel, how much would you require during the year without these ovens?

(Objected to, as it is not shown that the witness has made the trial with dry fuel, and as incompetent and hypothetical.)

A. About six hundred cords.

Int. 15. Do you run an engine, and how large?

A. We run from twenty to twenty-five horse power.

Int. 16. Do you use the heat for any other purpose?

A. We use the exhaust steam from the engine to heat the leaches.

Int. 17. What mason built this furnace?

A. Mr. Thurston.

Int. 18. Who instructed you how to use them?

(Same objection.)

A. Thompson was there at different times; Sarrenberger was there, the man Thompson employed.

60 U. S. Circuit Court, southern district of New York.

CHARLES N. BLACK, adm'r. &c., & an'or,
against
SAMUEL THORNE & others.

SAMUEL ARCHIBALD, a witness on the part of the plaintiffs, being about the age of sixty years, and having been first cautioned and sworn to testify the truth, the whole truth, and nothing but the truth in the matter of controversy, did depose, testify, and say as follows, viz.: I reside in the village of Oswego, N. Y., and am a tanner by trade.

Interrogatory 1. For how many years have you been engaged in the tanning business?

Answer. I built a tannery in 1838, myself, at Oswego, and I have been engaged in the business ever since.

Int. 2. Do you own the tannery your men occupy, and for how long?

A. I do, and have owned it since I built it in 1838.

Int. 3. Did you know Moses Thompson in his lifetime, and when did you first get acquainted with him?

A. I did; I think in 1854.

Int. 4. Did you ever see Thompson's furnace for burning wet tan, and if so, when and where?

A. At Marshal H. Weed's tannery, in Binghamton, either in 1854 or 1855, perhaps 1855.

Int. 5. Where did you first get acquainted with Moses Thompson?

61 A. At my tannery.

Int. 6. Did he then make any application to you for building a furnace for burning wet tan?

A. He did.

Int. 7. Did you see the furnace at Weed's work?

A. I did; I think I sent Thompson to Weed's before he was employed there.

Int. 8. Did you see Thompson at Weed's tannery when you saw the furnace there at work?

A. Yes, sir; once.

Int. 9. How long had Thompson been at work on the furnace then?

A. I don't know how long; he had completed the furnace and got it running.

Int. 10. Did you say anything to him about the iron grates in the furnace?

A. I don't know that I said anything about that; in fact I did not know at that time but that iron would do as well as fire brick.

Int. 11. Did you watch the operation of that furnace?

A. Some; not very particularly.

Int. 12. Did you erect one at your tannery?

A. I did.

Int. 13. When?

A. I think in 1855 or 1856.

Int. 14. For what use did you put it after you erected it?

A. For running an engine to run the hide mills and machinery, and for heating liquor.

Int. 15. State how your furnace was constructed.

A. I erected it like the model marked complainant's "Exhibit E," with the exception that I had two cylinder boilers in my furnace, the model showing only one.

Int. 16. After you got that furnace built, what kind of fuel did you use?

A. Spent leached or wet tan, after it had been ground.

62 Int. 17. State how you operated the furnace with wet tan.

A. We started the fire with wood in the first place, to get it heated up, and then applied the wet tan, feeding from the top—we

had two feed holes to each oven; my ovens were eight or nine feet long. I think there were three ovens. After furnace was nicely started we kept the ash pit doors pretty much closed. It don't require a very strong draught to burn wet tan in this furnace. We fed one furnace at a time. We commence, say, at the end furnace, and then fed along, as we wanted it, to the other end, when we would come back to the first one.

Int. 18. Any smoke come from the chimneys when the furnace was first started?

A. Yes, sir; then after it was in full operation and working well no smoke was visible.

Int. 19. How did you regulate the dampers?

A. Just as you wanted them. We shut down at night, we close all the dampers—that confines the fire wholly to the ovens. In one of these ovens, when so shut, if lately filled, it will smoke until the bark is charred all over, when there will be no more smoke and only just heat enough to keep up steam. In the morning we are ready for work. On starting we fill one oven; then when this is going nicely, the next, and so on—and so repeat through the day. The dampers are kept open through the day while running, and are closed when we shut down. There was a damper in the stack with which we regulated the draught as we required.

Int. 20. When the ovens were nicely burning what was the appearance in the mixing chamber?

(Objected to as immaterial.)

A. When it is all right we have a white heat in there.

Int. 21. Which would produce the most heat, a cord of wet tan, as used in this furnace, or a cord of dry tan or dry fuel, as used in an ordinary furnace?

63 (Objected to, as the proper foundation has not been laid for the question; as it is not shown that the witness has tried the experiment or made the test—the only facts from which a conclusion can be drawn.)

A. In my opinion a cord of wet tan, used in this furnace (Exhibit E), would give more heat than a cord of dry tan in the same furnace.

Int. 22. When the furnace is in full operation have you any fire in the ash pit—and how is it kept up?

A. By the tan falling through the grate bars.

Int. 23. How hot is it?

A. The grate bars are cherry red.

Int. 24. Is it essential to have the bars at a red heat?

A. They have got to be hot if you burn wet tan.

Int. 25. Who informed you how to conduct your furnace in the first instance?

A. Thompsom—James Weed stayed with me a week.

Int. 26. Did you have any instruction from Simpson?

A. I don't know that I have.

Int. 27. What kind of tan did you use?

A. Hemlock.

Int. 28. What shape were the heaps of tan in the oven after feeding?

A. A little round heap or stack.

Int. 29. How much air did you admit into this furnace for burning wet tan as compared with what would be necessary for burning the same amount of dry fuel?

(Objection to 21st repeated.)

A. We don't use near as much.

Int. 30. Did you ever see a Crockett furnace?

A. I don't know that I ever did to know it by that name.

64 Int. 31. Were you ever at the Candor tannery?

A. I have been—it belongs to Hoyt & Bosname; when I was there Howe, Lincoln & Elmendorf owned and run it.

Int. 32. Did you see a furnace at that tannery; if so, describe it?

(Objected to as immaterial.)

A. I did; it was altogether different from the model "Exhibit E;" the tan instead of being put in at the top was shoveled in at the doors in front, with a very large grate surface—the tan spread over thin—with a very strong draft.

Int. 33. Did you see any dry fuel used in it?

A. The tan was partially dried by being spread about a little in the engine room.

Int. 34. Was there any dry fuel used?

A. Some wood was used to start with, I guess; I saw coal dust mixed in with the tan; I have tried it myself a little, and in burning in this furnace I did not think it added enough to pay, but in the Candor furnace it works well.

Int. 35. Which furnace requires the most labor to feed, your furnace or the Candor furnace?

(Objected to as immaterial.)

A. I think the Candor furnace would require double the labor.

Int. 36. About how often did you let the fire go out in your furnace?

A. Not at all, except for repairs.

65 U. S. Circuit Court, southern district of New York.

CHARLES N. BLACK, complt.,
vs.
SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, jr., defendants.

Taking of depositions before John Whitehead, commissioner, &c., in behalf of complainant, at the city of Newark, New Jersey, on the 29th day of November, A. D. 1870.

WARREN CRELIN, a witness produced on the part of complainant, being duly sworn according to law, saith:

Interrogatory 1. What is your name, age, residence, and occupation?

Answer. Warren Crelin; 166 Oliver street, city of Newark, New-Jersey; I am forty-two years old, and an engineer.

Int. 2. Were you ever in the employ of Hoyt Brothers, in the city of Newark?

A. I was, as an engineer.

Int. 3. When were you first employed, as near as you can state?

66 A. I think it was fifteen or sixteen years since, as near as I could tell; I could not tell the year exactly.

Int. 4. How long were you in their employ?

A. Nearly six years.

Int. 5. Where?

A. In New York avenue, near Railroad avenue.

Int. 6. Had they any furnace there for burning wet tan?

A. Yes, sir.

67 Int. 10. What kind of grates were used in Hoyt's furnace, and of what material were they?

A. We called them a straight bar; they were of cast iron.

Int. 11. What were the inside measurement or dimensions of Hoyt's furnace?

A. I never measured the furnace in the inside; I think the outside was six by eight feet, if my memory serves me right; as this model stands it was eight feet front from the boiler up in this direction across to the front of the oven.

68 Int. 18. State the mode of using the ovens in firing up and keeping them going in operation?

A. I did not fire the furnace; I had a fireman; he did the firing, I run the engine; I fired and attended the coal furnace after we got it in.

Int. 19. Did you see it done?

A. Yes, sir; I saw some of it done.

Int. 20. Now state what you saw done

A. I never saw the fire a great deal; it was started by the watchman; whenever I saw it started we always put in our wood and shavings and get a fire the same as we would start a coal fire and put on the tan; we could keep feeding it as we required it by throwing in the tan.

Int. 21. About what quantity of tan did you keep upon the grate; how thick?

A. That would depend upon the weather; if the weather was damp on a rainy day the fuel was a little wetter than usual; we would have to make a thinner fire; I would not like to say how thick the fire was; I never measured it.

Int. 22. What condition was the tan in when used?

A. Well, we could cast a leach every day and drain it for a day or two; we threw it over into a shed, from which the fireman wheeled it down, and it was put into the furnace oven.

Int. 23. How was the water first applied to the bark?

A. I had nothing to do with the tanning yard, their foreman attended to that.

Int. 24. Was anything used with the tan as fuel?

A. We used Cumberland coal some.

69 Int. 28. When the furnace was in operation how were the ash-pit doors kept?

A. Generally kept open, I think.

70 U. S. Circuit Court, southern district of New York.

CHARLES N. BLACK, administrator of the estate of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, as administratrix of the estate of WILLIAM P. N. FITZGERALD, deceased,

vs.

SAMUEL THORNE et al.

WEDNESDAY, *January* 18, 1871.

Present: Counsel as before.

GEORGE J. WOODWARD, being duly sworn as a witness for the complainants, deposes and says:

Interrogatory 1. What is your name, age, residence, and occupation?

Answer. My name is Geo. J. Woodward; I am in my 47th
71 year; reside in Ulster county, New York; I work on all kinds of farming; anything I can get to do at this time of year.

Int. 2. Did you ever live in Woodstock, Ulster county; if so, state when you first went there to live?

A. Yes, sir; it was in 1854, about the 1st of October.

Int. 3. How long did you continue to live there?

A. About 14½ years.

Int. 4. What was your occupation during the time you lived at Woodstock?

A. Working at the tanners' beam; working in stock, fleshing hides.

Int. 5. At what tannery?

A. Woodstock tannery.

Int. 6. Who carried on that tannery when you first went there?

A. Nathaniel Bouton.

Int. 7. Who owned the property on which the tannery stood?

A. I heard them say it was leased from Mr. Gage; that's all I know about it.

Int. 8. Did you ever hear of Reese & Hoyt, or Hoyt Brothers, as connected with that tannery when you went there?

A. I heard of Hoyt Brothers.

Int. 9. Was there any other tannery in Woodstock except that?

A. Not in the village of Woodstock; I don't think there was any in the town of Woodstock but the one I refer to.

Int. 10. What month was it you first went there to work?

A. October, 1854.

Int. 11. Was there a furnace in that tannery when you went there?

A. Yes, sir.

Int. 12. Was it in operation?

A. Yes, sir.

Int. 13. What kind of fuel was used in it?

A. Wood and tan.

72 Int. 14. What was the furnace used for?

A. It was used for grinding bark, pumping liquors, rolling leather, and heating liquors by steam, generating steam for driving machinery.

Int. 15. What kind of tan was used in that furnace?

A. The principal part of it was hemlock tan; a litte oak sometimes.

Int. 16. In what condition was the tan when put into the furnace?

A. Generally wet, as we pitch it out of the leaches.

Int. 17. Was that so at all seasons of the year?

A. It was while Mr. Bouton carried it on.

Int. 18. For how long was that?

A. He carried on business there for about five years, I think.

Int. 19. How much tan did they put in the furnace at once?

A. They used to shovel in from two to four inches—sometimes spread it over the oven grate bars.

Int. 20. Did they put in any other kind of fuel besides this tan?

A. They used wood when they couldn't keep up steam enough with tan alone.

Int. 21. What was the general daily practice in this respect in feeding the furnace?

A. Well, sometimes they would have to use more and sometimes less, according to the work they had to do.

Int. 22. State, as near as you can, about how much wood they put in the furnace during the day, with the tan.

A. I couldn't tell anything about that; well, I couldn't tell to a certain amount; they used a little along occasionally.

Int. 23. What kind of wood did they use?

A. They used all kinds of mixed wood.

Int. 24. What were the dimensions of this furnace, as near as you can tell?

A. Well, I think the oven was about seven feet deep,

73 and very near as wide as it was deep, as near as I can tell.

Int. 25. About how many thousand hides did they tan in that tannery?

A. Probably they tanned from six to seven thousand hides a year; I can't tell exactly—may be over, may be less.

Int. 26. Did they consume all the tan that was made in that tannery?

A. No, sir.

Int. 27. What did they do with the tan not consumed in the furnace?

A. They run it out in the creek.

Int. 28 Was that the case when Mr. Bouton was there?

A. Yes, sir.

Int. 29. Is that furnace in the tannery yet?

A. Yes, sir.

Int. 30. After Mr. Bouton left, was there any change made in feeding it with tan?

A. They used to dry the tan in summer time, then they used that in the furnace.

Int. 31. What part of the year did they use the dry tan?

A. Well, from spring to fall, as long as they could dry it all through the summer.

Int. 32. Then in the fall, after they stopped drying tan, what did they use?

A. They used some wood with the wet tan then.

Int. 33. How frequently during the day would they use the wood?

A. Well, they had to put in wood once in a while during the day, to keep the fire up—could not tell how often during the day.

74 Cross-int. 112. What was the size of the oven?

75 A. About 7 feet from the furnace door to the boiler, and about the same width; about three feet high; might be more or less; I never measured.

Cross-int. 113. Did they have the engine running every day while Bouton had the works, exclusive of Sundays and holidays?

A. I think they did, more or less, every day; there was always something to do.

Cross-int. 114. Can you say that the same was true when Vandervoort took possession and run the tannery?

A. Yes, sir; I think it is.

Cross-int. 115. For how long was it the case after Vandervoort had possession?

A. He used to run every day as long as I worked for him.

Cross-int. 116. Why was Vandervoort required to dry his tan when, according to your statement, Bouton burnt his wet?

(Objected to as assuming what the witness has not said.)

A. He done it to save wood.

Cross-int. 117. Did Vandervoort burn any wood?

A. Yes, sir; lots of it in the winter time.

Cross-int. 118. What do you mean by lots of it—what quantity?

A. From one-fourth to a cord and a half a day—sometimes.

Cross-int. 119. Why does it differ in quantity on different days?

A. They don't have as much to do some days as they do others; that is the reason, I suppose, it differs.

Cross-int. 120. Did Mr. Vandervoort use wood during the time he was burning his dried tan during the summer?

A. I think he only used enough to start with in the morning when he used dried tan.

Cross-int. 121. How did he dry this dried tan?

76 A. Spread it over the yard.

Cross-int. 122. How large was the yard about?

A. Might have been about one-fourth of an acre, more or less; quite a nice yard.

Cross-int. 123. Who occupies the tannery now?

A. Mr. Vandervoort, I believe; he lives at Woodstock.

Cross-int. 124. Are you able to testify the amount of wet tan that was spread out in the yard at any one interval of time?

A. No, sir; I couldn't tell.

Adjourned to the 19th inst., at 9½ a. m.

THURSDAY, *January 19th*, 1871.

Present—Counsel as before.

Cross-examination of GEORGE J. WOODWARD resumed:

Cross-int. 125. Do you know what was the average amount of wood used daily in connection with wet tan, exclusive of kindling wood, at starting, in order to heat the oven during the time that Bouton had possession of the tannery and while you worked there for him?

A. No, sir; I couldn't tell how much.

Cross-int. 126. Do you know either about how much?

A. No; I couldn't tell how much; I have seen them putting wood in the furnace before now frequently, when I happened to be down that way.

Cross-int. 127. When you stated, then, yesterday, in answer to cross-int. 118, that there was burned from one-fourth to a cord and a half of wood a day sometimes, to what time and under whose administration or running of the tannery do you refer, and how did you yesterday arrive at this calculation, when this morning you cannot tell the amount?

77 (First part of question objected to as having been already answered.)

A. I think it was Mr. Vandervoort's time, as near as I can remember; I think he burned a good deal more wood than Mr. Bouton did.

Cross-int. 128. What would you call a good deal more?

A. I don't hardly know how to answer that question.

Cross-int. 129. Can you answer it at all?

A. Well, the way I can answer it, he used more steam for his liquors than Mr. Bouton did; he used to heat up more than Mr. Bouton did.

Cross-int. 130. Now, can you swear positively that Mr. Bouton, when he was using his engine for the running of his machinery only and without the heating of liquor, used any wood in connection with

his wet tan, other than what was required to start the fires in order to heat up the oven at the commencement of the operation of burning wet tan?

A. No; I couldn't swear positively to that.

78 United States District Court for the southern district of New York.

CHARLES N. BLACK, administrator of the estate of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, administratrix of the estate of WILLIAM P. N. FITZGERALD, deceased, plaintiffs,

vs.

SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, jr., defendants.

79 ROBERT DINGWELL, of full age, being duly sworn according to law, doth depose and say, as a witness for the complainants:

Interrogatory 1. What is your name, age, business, and residence?

Answer. Robert Dingwell; I am forty-two years old; I am a leather manufacturer; I reside at No. 28 State street, Newark, N. J.

Int. 2. Were you ever employed at Chadwick's?

A. I was.

Int. 3. Had they a furnace there for burning wet tan?

(Objected to as immaterial.)

A. They had.

Int. 4. How long were you employed there?

(Same objection as to last.)

A. Twenty-five or twenty-six years. My employment there commenced, I think, in 1844, and ended in 1869.

Int. 5. Are you acquainted with the furnace there, and the mode of operating it during that time?

(Same objection as to last.)

A. A portion of that time.

Int. 6. In what capacity were you employed there?

(Same objection as to last.)

A. From apprentice boy to superintendent of the establishment—superintendent of the manufacturing portion of the establishment.

Int. 7. During what time were you acquainted with the furnace and its operations?

80 (Same objection as to last.)

A. More particularly the last twelve years that I was there.

Int. 8. In what capacity were you there the last twelve years?

(Same objection as to last.)

A. About ten of them I was superintendent, the last ten—the other two I was foreman.

Int. 9. Look at this model, marked "Defendant's Exhibit 6," (Crockett furnace,) and state how far that furnace there resembled this model.

(Same objection as before; also as leading, incompetent, and improper.)

A. The difference of this is that it appears longer than wider than the one there, the one there being eight feet wide by six feet deep, or about that.

81 Int. 14. What fuel did you use?

(Same objection as to last.)

A. We used wet tan, and late years bituminous coal with it; former years we used anthracite coal in connection with the tan, both coals.

Int. 15. In what condition was the wet tan?

(Same objection as to last.)

A. Well, sometimes we would use it immediately after pitching it out of the leach, and at other times it might be laying out in the yard a few days, according to how much tan we had ahead.

Int. 16. How much coal was used; in what proportion?

(Same objection as to last.)

A. From 1,000 to 1,200 pounds of bituminous coal in 24 hours. We used more of the anthracite coal, from 1,500 to a ton a day if our works were in full operation. When we put in the Tupper bar we used from 800 to 1,000 pounds of the bituminous coal. The was chestnut and stove size, that is the anthracite; the bituminous coal was in the lump, which we crushed to about egg size, and some of it was smaller and dust.

Int. 17. When it was in operation how did you keep the ash-pit doors?

82 (Same objection as to the last.)

A. They were generally open; the other doors, the doors to the fuel chamber, were generally kept shut; sometimes the sliding doors in the door, the fuel doors, were left open—according to the heat.

Int. 18. What was the effect on the heat of keeping the sliding doors open?

(Same objection as to the last.)

A. To check it.

Int. 19. What was the effect of opening or closing the ash-pit door?

(Same objection as to the last.)

A. To open would increase the draft, to shut would decrease the draft; to increase the draft would increase the heat in the furnace.

Int. 20. Was any dry tan used at all?

(Same objection as to the last.)

A. Yes, sir; sometimes we would have a large pile of tan lying on the dock, and the outside would dry—we never purposely dried any tan for that purpose.

Int. 21. In what state, as to dryness or wetness, was the tan most usually burned?

(Same objection as to the last.)

A. It was wet.

Int. 22. Was there any fire in the ash pit at the time, or merely ashes, when it was in operation?

(Same objection as to the last.)

A. Merely ashes.

83 Int. 23. About how much did you keep on the bars, in feeding the furnace, of tan and coal?

(Same objection as to the last.)

A. Well, from ten to fifteen inches.

Int. 24. Did the condition of the weather make any difference in the amount you kept on the bars?

(Same objection as to the last.)

A. It did somewhat; in damp weather we didn't keep so thick a fire; in dry, clear weather we kept a thicker, a heavier covering; in damp weather say ten inches, in dry weather fifteen inches; I don't give this exactly; it was about that.

Int. 25. When it was in full operation would there be smoke or sparks at the top of the smoke stack, or would it be comparatively clear?

(Same objection as to the last.)

A. Sometimes it would smoke tremendously, and sometimes there would be many sparks; at other times it would be comparatively clear, and there would be a glimmer of heat.

Int. 26. What was the height of the smoke stack?

(Same objection as to the last.)

A. Originally, I think, it was forty (40) feet, and we had fifteen feet added; I think fifteen feet; about that.

Int. 27. Where is this furnace situated?

(Same objection as to the last.)

A. At the former Chadwick Patent Leather Works, at 40 Front street, Newark, N. J.

84 WEDNESDAY, *February 8th*, 1871.

Present—Counsel as before.

CONRAD KLEIN, called and sworn as a witness on the part of the complainant, deposes and says:

Interrogatory 1. What is your name, age, residence, and occupation?

Answer. My name is Conrad Klein; 52 years of age; reside at New London, Connecticut, and am a tanner and currier

Int. 2. How long have you been engaged in that occupation from first to last?

A. Since the 23d of January, 1833.

Int. 3. Where were you engaged in that business in the year 1855?

A. In the state of New York, in Cortlandt county, town of Homer.

85 Int. 4. Were you ever in the tannery of Marshall H. Weed, in Binghamton; and if so, when first?

A. I was; I believe it was in the forepart of 1855.

Int. 5. Did you see any furnace in there at that time; and if so, with what kind of fuel was it fed?

A. I did; it was fed with wet tan.

Int. 6. Was any fuel used in it, so far as you saw, except the wet tan?

A. There was not.

Int. 7. Were you the owner of a tannery at Homer at that time?

A. I was.

Int. 8. Had you ever seen wet tan burned in a furnace before you saw it at Weed's?

A. Not in the way they burned it there.

Int. 9. Did you construct or have a furnace constructed in your tannery for burning wet tan after that; and if so, how long after that?

A. I did have one constructed; I could not say the precise time, but think four or five months afterwards.

Int. 10. Who did you apply to, if any one, to construct or have that furnace built for you?

A. I believe Mr. Webster was his name; he lived in Binghamton.

Int. 11. Do you know B. D. Simpson, of Binghamton; and if so, did you make any application to him to build that furnace?

A. I knew Mr. Simpson, and I made an application to him to build the furnace.

Int. 12. In what capacity did Simpson act?

A. In the capacity of agent for Moses Thompson.

Int. 13. Describe how that furnace built by Mr. Webster for you was constructed; and if you have any sketch of it, produce that.

A. There was three furnaces, seven and a half feet long, three and a half feet wide at the bottom, each with two feeding-holes on the top of each; an opening at the back end of each furnace into a main flue situate under the boiler, with a hole in front twenty-
86 three inches square, with a plate on the top of the flue when the fire was not needed to shut it off; the flue was situated immediately under the end of the boiler; the boiler was nineteen feet long, three and a half feet in diameter, with return flue; smoke stack at the front of the boiler.

87 Int. 32. How many pounds of steam did you make with this furnace?

88 A. We made an average of forty-five pounds; I mean when I am running my works regularly.

Int. 33. How much dry wood would you have required to have made the same amount of steam and done the same amount of work which you did with wet tan in that furnace?

A. I think it would have taken from a cord and a half to two cords in twelve hours.

Int. 34. What was wood worth at that tannery a cord then?

A. A dollar and a half.

Int. 35. What was the wet tan worth that you used in the furnace, except for this purpose?

A. Nothing.

Int. 36. Which would have required the most labor to feed this furnace, with wet tan, or as an ordinary furnace, with wood?

A. To feed it with wood would have required the most labor; the man who attended this wet tan furnace attended to the engine, filled the ovens, attended to the sweat pits, and hauled the hides and attended to the hide mill; there was only one hide mill.

Int. 37. Where did you take the wet tan from in feeding it into the furnace?

A. From the leaches

Int. 38. Did you ever find it too wet for use in the furnace?

A. No, sir; the wetter it was the more heat it gave.

Int. 39. Did you ever undertake to drain it off, or dry it after you let the water out of the leaches?

A. We did not.

89 Circuit Court United States, southern district of New York.

CHARLES N. BLACK, administrator,
vs.
SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, jr. } In Equity.

DEPOSITION of witnesses taken by Robert H. McKune, United States commissioner and special examiner, on the part of complainants, for final hearing, under the 67th rule of the Supreme Court of the United States, Thursday, April 13th, 1871.

JEHIEL W. SNOW, called and sworn as a witness on the part of the complainant, deposes and says:

Interrogatory 1. What is your name, age, residence, and occupation?

Answer. Jehiel W. Snow; 61; city of Scranton; outside foreman at the Archibald manufactory in said city.

Int. 2. How long have you been engaged in that business?

A. About one year.

Int. 3. What was your business before that?

A. For several years, tanning.

Int. 4. Whereabouts; and if in connection with any one, with whom?

90 A. Azor Lathrop, of Montrose, Susquehanna county, Pennsylvania, and employed by other parties, from sixteen to twenty years.

Int. 5. Did you know Moses Thompson in his lifetime, or did you ever meet him; and if so, where?

A. I met a man by that name once at Brookdale tannery, Susquehanna county, state of Pennsylvania; I think in the year eighteen hundred and fifty-five.

Int. 6. What was your occupation at that time?

A. I was employed as the foreman of the Brookdale tannery of J. W. Brackney.

Int. 7. Was Moses Thompson doing anything there when you met him; and if so, what?

A. He was there giving a form for building some ovens for burning wet tan.

Int. 8. Were you ever employed at a tannery at Laporte, Sullivan county, Pennsylvania; if so, in what capacity, and when, and for how long, and for whom?

A. Yes; foreman of the tannery in eighteen hundred and sixty-five, about five weeks; Azor Lathrop sent me there; the tannery was carried on in the name of McFarlane & Thorne.

Int. 9. Was there any other tannery at that place?

A. I did not know of any other.

Int. 10. Had they a furnace in that tannery at that time; and if so, what kind of fuel was used in it?

A. Yes; they burned leached bark.

Int. 11. How many ovens had that furnace?

A. I think there were four.

Int. 12. How many boilers were attached to the furnace?

A. There were two.

Int. 13. Of what material was the furnace built?

A. With brick.

Int. 14. What kind of grate bars?

A. Cast iron.

Int. 15. Had the ovens or ash pit any doors?

A. Yes.

Int. 16. What did these ovens discharge into?

91 (Objected to as leading.)

A. Into what we call a mixing chamber.

Int. 20. Did you observe the operation of the furnace at the Laporte tannery when you was there?

A. Yes.

Int. 21. Had you yourself any charge of it?

92 A. Yes.

Int. 22. In feeding the furnace, state how you started the fire in the first instance.

A. By putting wood into the ovens until they had reached white heat.

Int. 23. Did you put any wood into the ash pits?

A. Yes.

Int. 24. Did you heat them to the same heat?

A. Yes.

Int. 25. After heating the ovens in this manner how did you proceed to feed them?

A. Rake out the live coals to one end, then put in bark to one end, so on through the whole four of ovens; when that bark got to burning, to haul out the balance of the coal, beginning at the other

end of the oven, and fill it; close up all of the doors, and let it work until it had burned down, so fill up again; then begin at the same place where I had first started from, and fill all around in same manner as often as they needed it.

Int. 26. In what condition was this bark fed in the ovens in this manner?

A. Wet bark taken from the leaches, the liquor drained out of it.

Int. 27. How long had the liquor been drained out of it before you used it in the furnace?

A. Did not take more than an hour or hour and a half to drain off. We con'menced to wheel it out of the leaches before it was thoroughly drained off, and put it in the furnace; it did not exceed two hours.

Int. 28. After commencing to burn the wet tan, the way you stated, in what position did you continue to keep the ash-pit doors?

A. Kept them closed as a usual thing.

Int. 29. What were these doors you used?

A. Made of a square piece of sheet iron.

Int. 30. In commencing to feed as as you have described, which end did you commence at, back or front?

A. Back end.

Int. 31. When you commenced to feed in that manner, did you not close the ash-pit door of the oven?

93 Int. 40. State whether or not the the charred tan fell through the grate bars in the ash pit in this furnace, at Laporte, when it was in operation?

A. Yes.

Int. 41. When the furnaces were in operation, was there any fire in the ash pit; and if so, how was it kept up?.

A. Kept up by the falling of the bark from the grate, when it is in operation; there is always a fire in the ash pit.

Int. 42. How did you usually keep the covers on the feed holes, when the furnace was in operation—off or on?

A. Always kept them on.

94 Circuit Court United States, southern district New York.

CHAS. N. BLACK, administrator,
vs.
SAMUEL THORNE, JAMES MCFARLANE and JONATHAN THORNE, JR. } In Equity.

DEPOSITION of witnesses, taken by Robert H. McKune, United States commissioner and special examiner, on the part of the complainant, for final hearing, under the 67th Rule of the Supreme Court of the United States.

FRIDAY, *April 14th*, 1871.

JACOB SMITH, called and sworn as a witness on the part of the complainant, deposes and says:

Interrogatory 1. What is your name, age, residence, and occupation?

Answer. Jacob Smith; age over 29; Bradford county, Pennsylvania; generally run an engine in a tannery.

Int. 2. State whether or not you were ever employed in a tannery at Laporte, Sullivan county, Pennsylvania; and if so, in what capacity, and when, and how long, and for whom?

A. I was employed there working in the yard from the 14th May until the 19th of June, 1869; from that date until first few days in August, same year, I run the engine and attended the fires in the furnace for McFarlane, of the defendants' firm of Thorne, McFarlane & Co.

Int. 12. When the furnace was in operation what was the temperature of the ash pit, hot or cold, when the furnace was in good burning operation?

A. Ash pit kept hot, except the water runs into it sometimes.

Int. 13. What produces the heat in the ash pit?

A. The tan what drops through.

95 THURSDAY, *May 25th*, 1871.

Present—Counsel as before.

JOHN S. ACKLEY, called and sworn as a witness on the part of the complainant, deposes and says:

Interrogatory 1. What is your name, age, residence, and occupation?

Answer. My name is John Ackley; age forty-two years; reside at Albion, Oswego county, New York, and have always been a lumberman except the four years I worked in a tannery—for the last four years.

Int. 2. In whose tannery did you work, and what was your occupation there?

A. Mr. McFarlane's and Thorne's, at Sandbank, Albion, Oswego county; for the first year I worked in the yard mostly, and for the last three years I worked around the engine, and during the last two years I run the engine myself during the daytime.

Int. 3. Who kept up the fire in the furnace during the daytime?

A. I did.

96 Int. 16. How did you operate that furnace in starting the fire?

A. I generally filled up every other one of those holes with tan bark, and then I would split up a lot of wood fine and build a fire in the ash pit; sometimes I would put a few sticks into the mouth of the ovens; when I got it well going I would fill the other holes with bark.

Int. 17. Which of the four holes did you first fill—front or back?

A. I would fill one back one and one front one; I would fill the

front hole of the first oven and the back hole of the second, and the front hole of the third and back hole of the fourth.

97 Int. 18. After the furnace got well heated, as you have stated, how did you continue to feed it?

A. In the same way.

Int. 19. Go on and state specifically the manner in which you would fill it.

A. I would fill one front and one back one, the same as I started; when one got burnt down I would fill it up some with bark; I would pass right around from one to the other; skip every other hole, the same as I did first.

Int. 20. About how often did you repeat this process?

A. When we had everything to work—about once every half hour, I should think. When we were not dying much we would not do it so often.

Int. 21. Where was the wet tan taken from with which you fed the furnace?

A. I took it from the top of the ovens. It was drawn in a cart from the leaches and dumped there on top of the ovens.

Int. 22. Did you ever feed all the ovens of this furnace at once?

A. Yes, sir.

Int. 23. What effect did that have on the fire?

A. It deadened the fire to fill them all at once.

Int. 24. For what purpose did you do this?

A. We did it always when we got through grinding, to deaden the fire, so that we wouldn't have so much steam.

Int. 25. Did you ever try feeding all the ovens at once for any considerable time; say several days?

A. No, sir; I did not.

Int. 26. What effect would such feeding, in your judgment, have on the fire?

(Objected to as incompetent.)

A. I don't think we could keep steam up by filling them up at once. It would keep the fire dead all the while.

98 Int. 27. Suppose you were to continue on feeding all the ovens of this furnace at once—what, in your judgment, would eventually be the result of that?

(Objected to as incompetent.)

A. My judgment would be that you wouldn't have a very good fire unless you burnt a great deal of wood.

Int. 28. In what position did you keep the ash-pit doors when this furnace was in operation and you required all the steam necessary to run your engine and grind bark?

A. I would move them, so as to leave a space of 4 or 5 inches, so as to get a draft.

Int. 29. State in what way you moved them—whether by setting them out or putting them to one side.

A. I would take hold of the handle and set them to one side, about 4 inches, I should think.

Int. 30. What are these ash-pit doors made of?

A. Sheet iron.

Int. 31. When you had the furnace in operation grinding bark and placed the ash-pit doors as you have stated, in what position did you place the dampers?

(Objected to as assuming that he did place the dampers, which he has not stated.)

A. The damper and the smoke-stack I would place about half open. That is all the damper I would disturb.

Int. 32. Did you ever, or not, when this furnace was in operation, open all the ash-pit doors, or put the doors to one side and open all the dampers; if so, what effect did that have on the fire?

A. Yes, sir; I have tried it. It made too much draft. The fire did not burn as good as if you had them partly closed.

Int. 33. What did you do with the covers on the feed holes when this furnace was in operation?

99 A. I always kept them over the holes, principally. I had to, to keep the fire from flying. If I did not keep them down the fire would fly all over the tannery most.

Int. 34. Did you ever try filling any of these feed holes and leaving the cover off, depending upon letting it feed itself?

A. I have filled it up before now and stamped it down hard when they were going to dump some on the ovens. It wouldn't last but a little while. It would burn right up through. You had to watch it.

Int. 35. Was there any fire in the ash pit of these ovens when the furnace was in good burning operation?

A. Yes, sir; there was a good hot fire in them all the while.

Int. 36. How was this fire produced, and how kept up?

A. By charred tan falling through the grates.

Int. 37. How much of this tan did you usually have in the ash pits when the furnace was in operation?

A. We usually had them two-thirds full, I guess; sometimes more. We had to rake out a little of it—run a scraper in and pull out some.

Int. 38. Did you ever try running this furnace without a fire in the ash pit, by the use of wet tan?

A. No, sir; I never did.

Int. 39. Did the ash pits ever get cold from any cause; if so, what effect did that have on the fire?

A. If they got cold we always split up a little wood fine and started a fire to heat them up. The fire wouldn't burn as well with the ash pits cold—wouldn't burn at all, hardly.

Int. 40. Did you ever look in the flue under the boiler when this furnace was in operation; and if so, what appearance did this heat exhibit there?

A. Yes, sir; I have looked under there a great many times, and there was generally a very hot blaze of fire under there.

Int. 41. If you had opened the damper entirely in the

chimney when this furnace was in operation, in what
100 position, in your judgment, would you have to keep the ash-pit doors?

(Objected to as incompetent.)

A. Well, I should think you would have to keep them closed.

Int. 42. When you stopped grinding how did you regulate the fire in the furnace?

(Objected to, as assuming that the witness regulated the fire after grinding, which fact has not been stated by him.)

A. I closed all the dampers, and filled the oven up with wet tan.

Int. 43. The ash-pit doors, what did you do with them?

A. I always closed them tight.

Int. 44. Did you ever take the dimensions of this furnace by measurement?

A. I did, sir.

Int. 45. When, and at whose request, and who was present, if anybody?

A. About a year and a half ago, at Mr. Jacob Moore's request, and he was present at the time.

Int. 46. How many cords of dry wood would be required for 24 hours to give the same heat that was produced in this furnace by the use of wet tan?

A. I never tried it—don't know as I can tell; it would take four or five, I should think.

Int. 47. What kind of a heat does this wet tan produce, as to density?

A. It makes a very steady, hot fire; it makes a steadier fire than wood would.

Int. 48. What is wood worth at that tannery?

A. Three foot wood is worth 18 shillings; 4 foot wood is worth $3.00.

101 U. S. Circuit Court, southern district of New York, June 16, 17, 1871.

CHARLES N. BLACK, administrator of estate of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, administratrix of estate of W. P. N. FITZGERALD, deceased,

vs.

THORNE, MCFARLANE & Co. and others.

In Equity.

Before Commissioner STILWELL.

C. N. BLACK, for complainants, and ANDREW J. TODD, for defendants.

BENJAMIN SILLIMAN, called and sworn as a witness on the part of the complainants, deposes and says:

Interrogatory 1. What is your age, residence, and occupation;

and have you ever been called upon to testify as a scientific witness in patent cases; and if so, how frequently?

Answer. Benjamin Silliman; 54 years of age; reside in New Haven, Connecticut; and have been for more than thirty years in the practice of chemistry as a profession, and as a professor in Yale College; I have been frequently called upon to testify as an expert in causes requiring scientific testimony.

Int. 2. Were you acquainted with Moses Thompson in his lifetime, and have you from personal examination and experi-
102 ence, acquaintance with the construction, operation, and mode of using Moses Thompson's furnaces for burning wet fuels, as described in his patents of March 31, 1857, and December 15, 1857, marked complainants' Exhibits G and H, and shown by the models Exhibits E and F, or either of them, and if so, state the same, and give your reasons for any conclusions you may deduce therefrom?

A. I was personally acquainted with Moses Thompson; I made his acquaintance in 1857, when he called upon me to consult with me professionally, and to explain to me the principles and mode of action of his furnaces for burning wet fuel; after hearing his statements, and perceiving, as I conceived, the importance of his invention, I determined to investigate the construction and operation of his furnace more maturely; for this purpose I sent my manager and assayer, Mr. Ludwig Stadtmuller, in company with Mr. Thompson, into the state of New York, to examine certain of Thompson's furnaces, which were then, and I believe still are in action, consuming wet tan at or near the town of Deposit; Mr. Stadtmuller's report to me of the operation of these furnaces fully confirmed what Mr. Thompson had previously stated to me, and I therefore contracted with him on behalf of the company which I represented to erect at the Bristol Copper Mines, in Hartford county, in Connecticut, which I was then conducting, as president of the company, a furnace on his general plan, but to be specially adapted to the consumption or burning of wet peat, of which there was an ample supply upon the property in question; the building of this furnace was an experiment, as up to that time Thompson had never constructed one of his furnaces for the burning of this specific kind of fuel, and he himself expressed to me some doubt of its entire success in the first trial, both because he was uncertain as to the proper size to be given to the openings between the grate bars, and also because the peat, in the condition in which we pro-
posed to use it, carried about three-fourths of its weight of
103 water, even after some days' exposure to the air. I naturally watched the construction of this furnace with care, and after it was brought into action studied its performances with attention. The furnace worked well, better than I expected, in view of the unfavorable conditions just named. It required, as well I now remember, about one cord of wood to three cords of wet peat in 24 hours, and its practical effect was judged by those who watched its perform-

ances to be equal to that which was obtained previously by the use of four cords of wood, consumed under the same boilers. I should say that the sole use which we had for this furnace was for the purpose of raising steam. The cost of the peat was the value of the services of one man and of a horse and cart during the ten hours of the day, at a time when wood was costing us five or six dollars a cord, and anthracite coal laid down at the mines cost us about eight dollars per ton. Had the changes in the width of the grate bars (which experience proved to have been set too close for the easy delivery of this bulky kind of fuel into the ash pit or incineration chamber), contemplated by Mr. Thompson, been carried out, I have but little doubt that we should have been able to consume the peat without the addition of any wood, especially if it had been allowed a few weeks to dry, so that it should have contained not more than 50 per cent. of water.

I have since that time had opportunity to acquaint myself with the action of Thompson's furnaces, as I have seen them in action at the tannery of J. B. Weed & Co., where Thompson in 1854, if I am correctly informed, built his first furnace for burning wet tan, at Binghamton, in the state of New York. I will, therefore, in more explicit answer to the interrogatory, proceed to explain my views of its action. Thompson says, in his patent of March 31, 1857, "the main object of my invention is to effect the more economical use for fuel of tan bark, begasse, or other trashy matter in a wet state, or very green or wet wood." He then proceeds to de-
104 scribe the general arrangement of a furnace suited to the purposes of his invention, not claiming any specific mechanical detail of construction in the series of fire chambers, communicating with a common flue, which he distinguishes as a "mixing chamber," irrespective of the purpose for which he uses the same and the manner in which he employs the arrangement which he describes, but he distinctly contemplates in both his patents of 1857 and in his caveat of August 17, 1853, the following as the essential conditions for the successful burning of wet fuel, however the same may be constructed, to wit:

First.—A series of chambers or spaces into which the wet fuel destined for combustion is to be charged alternately through openings provided for that purpose in the top of the arch or vault of masonry surmounting the chambers, and placed side in a series of two or more, as convenience may dictate, and separated from each other in such a manner that each vault or chamber shall be independent of the others, and provided on top with openings or feed holes, each vault or chamber discharging by an opening or flue in its rear in a common receptacle or chamber.

Second.—A grating, preferably of fire brick, with openings suited to the nature of the fuel to be burned, and on which the burden of wet fuel reposes as it falls from the feed hole preparatory to combustion.

Third.—An ash pit or incineration chamber, so arranged that it

may receive more or less air by means of doors or dampers which are regulated to control the combustion of the fuel falling into them through the interstices of the grating as it is dried, and ignited in the combustion chamber.

Fourth.—A longitudinal canal or flue of masonry, into which all the products of combustion from both the upper and lower
105 fire-places are discharged as they arrive from the several fuel chambers, and in which flue or mixing chamber (as Thompson calls it) an intense action is maintained between the several factors there present, resulting in the complete consumption of all carbonaceous matter, and in the production of an intense heat. This action may, if desired, be regulated by dampers attached to the outlet or discharge flue of each of the upper fuel chambers, or it may be effected by the alternate mode of charging at the several feed holes opening into the fuel chambers. These fuel chambers are also provided with cast-iron doors on the outer walls, but these doors are never used for charging in fuel after the furnaces are once brought into action, and are kept carefully closed. Thompson says in his patent of Dec., 1857, "a large and hot fire should always be preserved in the fire chamber below the grate and directly under the charge of wet fuel for the purpose of driving the vapor out of it, and charring its lower portion, and the grate is left much more open than in furnaces for burning dry fuel, for the purpose of allowing the charred portions of the wet charge to fall through to supply fuel for this fire, as fast as it becomes fit for that purpose, thus consuming the mass with little or no expenditure of other fuel."

Thompson claims, first, the "combination of two chambers, the one above the other and separated by a grate, the lower one for the combustion for any known dry carbonaceous fuel, and the upper one in immediate proximity therewith to receive heat therefrom, for heating and drying the charge of wet fuel; with a mixing chamber into which both continuously and simultaneously discharge their gases before reaching the thing to be heated, for mingling and mutual combustion."

He also claims, "in combination with said fire chamber and wet fuel chamber, or drying chamber, making the grate upon which the wet charge rests sufficiently open to allow the lower portion of the wet charge, as it becomes dried and charred, to fall
106 through into the fire chamber, and keep a hot fire therein, supplying the place of other dry fuel while the uncharred portion of the wet fuel is properly supported by the grate till dried as described."

He also claims, "placing the mixing chamber of combustion in substantially the same position described relatively to this fire, and the wet charge, so that the products of combustion from the dry fuel may pass along the lower part of the wet charge, drying and charring it on their way to the mixing chamber, and reach it without being in any considerable degree obstructed or cooled by the wet charge, substantially as shown," &c.

My observation and experience have taught me that the actual working of Thompson's furnace is substantially as follows: The temperature of the entire structure having first been brought up to a satisfactory point by the use of a sufficient quantity of dry fuel and the incineration chamber, or ash pit, being filled with highly ignited fuel, the wet fuel to be consumed is charged in at the alternate openings in the following order. The letters A, B, C, &c., being placed in the order in which the openings stand to each other in a furnace of four chambers, each fuel chamber having, in the case supposed, two feed holes: the order is thus expressed, as seen from above, the numerals 1, 2, 3, 4 standing for the furnaces respectively, to wit:

B	D	F	H
A	C	E	G
1	2	3	4

A, D, E, H are first charged.

The fuel falling in a conical pile, the broad base of which rests upon the grating and receiving the heat from the incineration chamber or ash pit, which by the statement is filled
107 with carbonaceous fuel, the product of previous combustion, and kept in a very active condition of ignition. The surface of the four cones of wet fuel commences immediately to lose water by evaporation, turns black by incipient combustion, and is presently ignited by the powerful heat reflected from the vaults and surrounding hot walls of the upper or wet fuel chamber, as well as by the heat derived from the carbonaceous fuel burning in the ash pit or incineration chamber. In a short time the surface of these several cones of fuel commences to shower down glowing particles, through the grating into the incineration chamber, adding their effect to the already reduced stock of highly ignited carbon therein. The surface of the conical heap, as viewed through a peep hole in the iron doors of the fuel chamber, now appears all aglow with incipient combustion, but if this glowing surface is broken by means of an iron rod, it is at once seen to be only a shell of fire surrounding a black and smoldering mass, which, a little further in, is perceived, when disturbed, to be, at the nucleus, simply wet tan waiting its turn to undergo the same change, and ultimately to find itself projected in a fiery shower into the incineration chamber. It is now time, when this process is sufficiently advanced, to charge in like manner as before the remaining alternate feed holes, B, C, F, G, each with their appropriate quantity of wet fuel. Thus the al-

ternate order of charging is established, and the furnace, fed by the combustion products of these several fires, is brought into steady and uniform action. The incineration chambers or ash pits must at all times be furnished each with their appropriate quantity of carbonaceous fuel in full combustion, and the eye at once recognizes from the high heat therein visible the proper conditions of successful action. If too much air is admitted to these lower combustion chambers, the temperature at once falls, and presently after smoke may be seen issuing from the stack, indicating the fact that the proper conditions of successful action of the furnace are no
108 longer present. The amount of air to be admitted is regulated by the height of the stack and the use of its damper. If the stack is high and its damper open, the doors of the incineration chamber must be closed so that only a modicum of air may be admitted; if the damper of the stack, however, is partially closed, the lower openings must be regulated accordingly, with a skill which the furnace man very soon learns to exercise. Bearing in mind the order just described, it will be observed that each separate fuel chamber is simultaneously discharging into the common flue, with which they are all connected, two distinct classes of products, to wit:

First.—Those of high temperature coming from the incineration chamber, and composed chiefly of carbonic acid and vapor of water mingled with nitrogen, the residual gas of the atmosphere from which its oxygen has been more or less completely removed in the combustion chamber; and

Second.—Products of imperfect combustion, of a lower temperature, derived from the conical piles of wet fuel, which, under the process of destructive distillation, are yielding far more complicated products, chiefly watery vapor, carbonic oxide, carbonic acid, free carbon or smoke, and various hydro-carbons, of which the most important is light carburetted hydrogen, or marsh gas. These latter products form together what is commonly called smoke, but, as already stated, there is no smoke appearing at the mouth of the stack when the furnaces are acting properly, as I have described. What then becomes of the smoke; that is, of the complicated products of the combustion of wet fuel given off at the surface of the conical heaps in the upper combustion chambers during the process described? The answer is easy. In the mixing chamber, as Thompson calls it, that is, in the common space or flue beyond the furnaces, these several factors react upon each other at a temperature which permits the unconsumed carbon of the process to borrow oxy-
109 gen from the vapor of water to form chiefly carbonic acid, while the hydogen and carburretted hydrogen, and any carbonic oxide which may be present, in their progress toward the stack find oxygen, with which to form water and carbonic acid, giving in this reaction flames, as well as hot gases, to tell upon the boiler or other object to be heated. Thus the final products which find their way out at the stack are only vapor of water, carbonic acid, and the residual

nitrogen of the air. The temperature of the mixing chamber, where these final reactions occur, is considerably elevated, as may be seen from the white heat to which the fire bricks are there raised, when viewed through the openings accessible at the end of the mixing chamber.

Such, in brief, and in as simple language as the subject admits of, and stripped of all unnecessary theoretical considerations, is the operation of Moses Thompson's wet fuel furnaces, as I understand them, and as the result of my own observation and experience in the study of their phenomena. In addition to what has been said, it is to be remembered that the large amount of heat stored up in the masonry of the arches, walls and gratings, in both sets of combustion chambers in Thompson's furnace, serves as a reserve force, accumulated in a manner analogous to the stored up momentum in the fly-wheel of a prime motor tending to equalize the action of the whole, and to prevent any sensible decline of temperature consequent upon the great amount of heat absorbed in converting the water into the state of vapor.

This principle has been, long subsequent to Thompson's invention, seized upon in the construction of "Siemens's Regenerative Gas Furnace" in a most striking and beautiful manner, but it is irrelevant to our present purpose here to enlarge upon it.

Moreover, it is important, in considering the action of Thompson's furnace, to recall one or two very plain points, which might otherwise, perhaps, escape our notice if not specifically mentioned, to wit:

110 *First.* While it is accepted as an established principle of the science of heat that the amount of useful effect in any given quantity of mixed fuel is just that which is due to calorific value of the simple carbon it contains,* that this is true only when the carbon is burned at once in oxygen alone, and that in the best case known to experience it is believed that not over one-twentieth of the total calorie effect possible in the combustion of fuel is capable of being applied in producing actual work, and hence it follows:

Second. That while theoretically the same number of units of heat are evolved from the combination of a given amount of carbon with oxygen, whatever length of time may be consumed in the combustion, yet practically, other things being equal, the more rapidly the chemical action is accomplished the more effectual for useful purposes will be the result. The slow combustion of a stately tree fallen in the forest by the action of the oxygen of the air extending through years of decay will evolve the same number of units of heat which would result from its rapid combustion as fuel in the furnace of a steam boiler, while it is obvious that the length of time consumed in the first case deprives the combustion not only of all useful effect, but that there is at no one instant of time even a sensible elevation of

* See p. 294 for a correction of this statement.

temperature consequent upon the conversion of its carbon into carbonic acid, or of its hydrogen into water.

If now we read Moses Thompson's specifications and his claim as set forth in his patent for his wet fuel furnaces in view of the facts and reasons herein stated, we must clearly perceive that he distinctly grasped all the essential features of the problem to be solved, namely, how economically and practically to burn wet fuel, and if we find that his statements of the scientific principles involved in this problem are insufficient, or erroneous in any particular, we see that there is no want of a clear and definite statement of the methods by which he proposed to accomplish his purpose. His invention consists in
111 the artful and judicious combination of several distinct and separate features, for each one of which, separately considered, we may, perhaps, find a guide or hint in the literature of this department of practical art prior to his time. But no record exists, so far as my reading or knowledge extends, of any similar or identical combination of these several essential features in one invention, for the purpose and substantially in the manner conceived of and executed by Thompson, and by him described in his several records of his own inventions.

It is but fair in forming our judgment of the merits of an invention to consider what was the state of the art prior thereto and what it now is, as a consequence of the application of the inventive power or genius of the inventor. Viewed in this light we find that, prior to the filing of Moses Thompson's caveat, in August, 1853, several of the mechanic arts were encumbered with useless and waste materials, the result of manufacturing processes which required in some cases labor and expense for their removal. Now we observe that these same arts, as a consequence of Thompson's study and experiments, and of the use of his methods, as set forth in his several patents, are enriched by the utilization of those previously waste products to the manifest advantage of the manufacturer. A considerate regard for truth also requires us to remember that at the date of filing Thompson's caveat, in 1853, the state of the art of building and management of furnaces, the utilization of fuel, and the application of heat was by far less perfectly developed than at present, and consequently that the lights which were then available to guide a practical inventor like Thompson in the application of scientific principles, now happily open and available to all, were at that time comparatively few and of difficult access, and of consequence the merit of the inventor who successfully coped with such problems was all the greater.

Int. 3. Are you acquainted, from personal examination, with the construction, operation and mode of using the so-called Crockett and Morrison furnaces, as described by the exhibits marked de-
112 fendants' Exhibit 5, 6, 9, 13, Morrison, Morrison No. 2, and if so, state the same and how far they are or either of them are analogous to the said Thompson furnaces, or either of them, with

your reasons or any conclusions you may give, or statements you may make?

A. I have read the documentary evidence presented in Exhibit No. 9, being D. B. Crockett's application for a patent in December, 1853, described as a furnace for burning smoke or unconsumed gases. I have also read the rejected application of John Morrison, bearing date March 22, 1854, being for a furnace for burning wet substances. I have also had opportunity to examine the several models referred to, as 5, 6, 13, and model marked Morrison Model No. 6, purporting to be a model substantially in accordance with the specifications of Crockett's rejected patent above referred to. I also have had an opportunity of examining the so-called Crockett furnace, which I found in action in a tannery at Sparrowbush, near the town of Port Jervis, belonging to Messrs. Swazey, Cooper & Co., and belonging formerly, as I understand, to Morris M. Schultz. I there saw two of these furnaces in action. At the upper works the furnace is double, having one chamber to each of the two boilers. The dimensions of this furnace are as follows: Width of the furnace block over all, 16 feet; with of furnace walls out, 10 feet. The walls were 30 inches on the two sides; the division wall, dividing the furnaces, 18 inches. Each furnace has a clear width of about 5 feet, and a depth from front to rear of about 6 feet; area of the grate surface about 30 square feet; height of the arch over the grating 2 feet 6 inches; furnace and ash-pit doors, each 18 inches square, of cast iron. I found the ash-pit door of this furnace wide open, and there was no fire in the ash pit. The fuel was what the men called sprinkled tan, mixed with a portion of dry wood. This tan is not properly called wet tan, having been through the centrifugals, and might be called practically dry tan.

113 It was spread level upon the grate bars, which were of iron, in a coating several inches in thickness. Its surface for the most part was black, with bright holes here and there, through which the draught of air came up. Combustion was attended with the evolution of considerable smoke, for the combustion of which no provision was made, and all the products of combustion from each furnace were delivered under the boilers, which were set endwise to the furnace.

There appeared to be, or to have been, a bridge wall, but at the time of my visit this bridge wall was broken down, and the workmen complained that for some reason, whether from the breaking down of the bridge wall or from the prevalence of damp and unfavorable weather, the furnace was not acting well, and they were compelled to use a large proportion of dry wood in order to keep up steam.

(The statements of other parties to the witness objected to by counsel for defendants as hearsay.)

The furnace appeared to me to be one of ordinary construction, with open ash pits, differing in no respect, so far as I could observe, from ordinary furnaces attached to steam boilers, except in the feature of a low arch of brick work over the combustion chamber. The

combustion was exceedingly imperfect, producing but little heat and considerable smoke. The grate bars were set quite close together, and were of iron. After the products of combustion left the combustion chamber they were delivered under the shell of each boiler and returned by flues through the boiler, and so back to the chimney. I learned that these two furnaces burned about ten cords of tan for 24 hours, and I observed that they required attention from the firemen for stoking and regulating the fire once in about fifteen minutes.

114 At the lower mill of the same establishment I found a similar furnace, a single one, newly constructed, and acting upon a single boiler. It appeared to me to be in all respects similar in construction, in action, and in the condition of the fuel to that which I have already described as witnessed in the upper furnaces. The tan upon the grate bars, which were of iron, was black and smouldering, with a few bright spots here and there. No use was made of the ash pit as an incineration chamber, the door of the ash pit being wide open. These furnaces showed to me no similarity in their mode of action, or in their essential construction, to the furnaces of Moses Thompson, and are to be considered as only very imperfect and unsatisfactory means of utilizing the fuel which they consumed. The temperature of no part of these furnaces, as I saw them in action, was adequate to enable them to act as do the furnaces of Moses Thompson, nor, in my opinion, would they act at all economically unless they were supplied with a portion of dry wood, or other fuel, to aid in preparing the tan for combustion.

In comparing the description and its accompany drawings, as contained in the rejected patent of Crockett (defendants' Exhibit No. 9), with the furnaces which I have described as having been seen by me in action at Port Jervis, it is to be observed that there are some formal differences of construction; for example, the flue R shown in his figure 5, for the purpose, as he describes, of reversing the current in his apparatus, did not exist, so far as I could detect, in the furnaces which I examined at Sparrowbush, nor do I observe in the model (marked defendants' Exhibit No. 6) any reproduction of this feature. In comparing the furnace of Crockett, whether from his drawings and specifications, or from the furnaces which I have seen in action as just described, and stated to be built substantially in accordance with Crockett's ideas, with the several specifications and drawings of Moses Thompson, and with the furnaces which I have seen in action that have been constructed in accordance with the specifications of the latter inventor, I observe the following, which appear to me to be essential points of difference in the two cases:

115 *First.*—There is no provision in the furnaces of Crockett for any alteration of feeding, nor, so far as I can learn, is any such usage maintained and practiced. It is obvious, from simple inspection of the defendants' Exhibit No. 6, (being their model of Crockett's furnace,) that while there are two ash-pit doors, two exterior iron doors at the front of the furnace, and two feed holes upon the top of the same, that there is only one furnace or combustion

chamber, viz., the upper one, covered by a simple vault of masonry, provided, as at Sparrowbush, with ordinary gratings of iron, discharging into an ash pit which is an open space, as seen in the model Exhibit 6, common to the entire furnace. In view of the practice which I have seen and described in the furnace at Sparrowbush, and equally by inference, if I judge correctly from the model Exhibit No. 6, it was neither the intent of the inventor, nor is it the practice of those who employ his invention, to avail themselves of the principle of alternate feeding, nor was it the intention of the inventor, so far as I can discover from perusal of his specifications, and certainly it is not the practice of those who employ his invention, to make use of ash pits as incineration chambers for the regulated and vigorous combustion of carbonaceous fuel fallen into them from the raw fuel charged into the upper combustion chambers, which in the furnaces of Crockett are the only chambers of combustion provided for. As a consequence of these essential differences in the construction and method of using these two furnaces, it is not possible, in my judgment, so to employ the furnaces of Crockett as to produce a temperature sufficiently elevated to accomplish the objects, which are so perfectly accomplished in the furnace of Thompson by the combined action of the several parts therein described, and which I have fully detailed in my answer to the second question. In other words, it is not possible, as I understand it, to obtain from the furnace of Crockett, as he has described it, and as it is actually used by those who employ his invention, a full and
116 economical use of the wet fuel for the consumption of which the furnace purports to have been invented and constructed. That I am justified in this conclusion is evident from the condition in which I found these furnaces when in actual operation, and also from the fact that it was essential even in sustaining the imperfect degree of combustion which I have described as existing therein, to employ at all times a notable proportion of dry fuel. Referring to the drawings which accompany the specifications of Crockett, it is obvious that the bridge wall H, and its corresponding wall J, stand in such relation to each other that the space K, which is included between them, might properly be called a mixing chamber, somewhat similar in its character to that portion of Thompson's furnace which he distinguishes by this name, and which is marked F in his drawings attached to his reissued patent, No. 446, of the 31st of March, 1857. I observe, however, in defendants' Exhibit No. 6, that the model purporting to represent the invention of Crockett does not reproduce, in any proper sense, the hot flue or mixing chamber, marked K, in Figures 4 and 5 of Crockett's rejected patent. I was unable, of my own knowledge, to observe in the furnaces at Sparrowbush whether this feature of Crockett's specifications was, in any proper sense of the term, a mixing chamber. but so far as an ocular inspection from the mouth of the furnace could instruct me on this point, the Sparrowbush furnaces do not reproduce this feature of Crockett's specifications, the whole products of combustion

therein, as I have already stated in the former part of this answer, appearing to me to discharge themselves directly beneath the shell of the boilers, which I could distinctly see; nor do I believe, from anything that I saw, that those furnaces reproduce in their construction the chamber, flue, or space which is marked K in the drawings of Crockett. Granting that Crockett's furnaces should be constructed strictly in accordance with his specifications and drawing as set forth in his rejected patent of the 22d of December, 1853, I do not see how it is possible that they should act in the manner speci-
117 fied and described in the patents of Moses Thompson, seeing that they would still lack the essential features of alternate feeding, of carbonaceous fires contained in the ash pits, or incineration chambers, and the regulated draft of the latter controlled by the closed, or nearly closed ash-pit doors.

I have introduced the term "incineration chamber" in my description of the action of the furnaces of Thompson, not importing it from the language of his patent, but employing it as a descriptive term, which, in my judgment, reflects precisely the thought which existed in the mind of Thompson at the time he wrote those remarkable passages in his patent of December, 1857, which I have cited in my answer to the second interrogatory. In that same instrument, both in the text and the accompanying drawings, Thompson clearly recognizes the important difference between an ash pit in the sense in which that term is ordinarily implied, simply as a receptacle for the ashes of a previous combustion, accomplished in another fireplace, and that essential feature of his invention which regards this space, which I have called an incineration chamber, as a place for the convenient reception of ignited carbonaceous fuel prepared by drying and ignition in another place especially adapted therefor, therein to complete its combustion at a high temperature, as already sufficiently described by me in a former answer. I wish distinctly to state that the invention of Crockett lacks this important feature, so essential to the combustion of wet fuel, and without which it is not possible to maintain, when this kind of fuel is employed, a temperature sufficiently high for its perfect and economical combustion. It is obvious, moreover, in view of the facts already stated, that if the furnace of Crockett, constructed in accordance with his specification, and as I have seen it, having grate bars of iron, should be sought to be employed in the manner of Thompson, by employing the ash pits, which are now strictly and exclusively such, as chambers of incineration, the result obviously would be the speedy de-
struction and melting down of the grate bars, an accident
118 which soon taught Thompson the indispensable importance of employing in his furnace grate bars of fire brick. The inference appears to be conclusive from this fact, that Crockett never intended the ash pits in his furnace to serve any other purpose than that which this name implies, and that such was the fact is obvious from the actual usage of those who employ his invention.

John Morrison, defendants' Exhibit Morrison No. 2, applied March

22, 1854, for a patent for a "furnace burning wet substances;" all the reasoning which I have employed in the previous part of this answer, in reference to the furnace of Crockett, applies with equal force in its general scope and in its limitations to the supposed invention of Morrison, and it appears to me needless to restate this evidence in considering his application for a patent, which the Patent Office saw fit to reject for the reasons assigned in the correspondence forming part of the Exhibit Morrison No. 2.

Defendants' Exhibit No. 5, called Woodstock furnace, also their exhibit marked "Morrison, R. E. S.," and also defendants' Exhibit No. 13, being models of three furnaces, which, as I am informed, have been, at different times and at different places, employed for the consumption of wet fuel, appear to me to present no features which distinguish them as differing essentially in their construction and mode of operation from the furnace of Crockett, and the further consideration thereof would only involve the repetition of the same line of reasoning which I have already stated with what I regard as sufficient fullness in that portion of my present answer which I have devoted to the discussion of Crockett's furnace, and to what I consider as the essential points of difference between that and the furnace of Thompson.

Int. 4. Have you examined the printed publications marked defendants' Exhibits Nos. 7, 8, 14, 15, and 20; and if so, describe in detail as to each one, how far it is or is not analogous to the said Thompson furnaces, or either of them, and give your reasons for your answer?

119 A. I have, and will answer in detail. Exhibit No. 7 makes reference to several distinct paragraphs in the well-known treatise upon heat by the distinguished French author, E. Peclet. I have before me the third edition of that author, in which I identify the corresponding sections which in the exhibit are quoted from the second edition as sections or paragraphs as 623, 624, 625, 626, 627. All of these references are to furnaces constructed for the purpose of self-feeding, in which the fuel is introduced in a somewhat circuitous passage, while the access of air for draft is by another passage sometimes above and sometimes below the fuel, the object in view being to confine the action of the air to that portion of the fuel which has already arrived in its descent by gravity or otherwise at the point of combustion. I see nothing in either of these citations which appears to me to have any important bearing upon the points at issue in this controversy. In section 633 of the same edition of Peclet is a description of a furnace contrived 1795 by James Watt, which was designed as a smoke-consuming furnace, acting by means of two fires, placed side by side, and fed alternately by raw fuel, the products of the combustion from which are made to pass across the other fire, already in a state of high ignition. This furnace appears to me to be identical in principle and in its essential construction with the furnace patented by Thomas Hall, English patent, A. D. 1839, No. 7,974, being defendants' Exhibit No. 14, and which the

inventor declares to "be a new combination or arrangement of parts forming an improved furnace for consuming smoke and economizing fuel, applicable to steam engine boilers and other furnaces." The original furnace of Watt appears to be the parent of a large class of similar inventions, of which that patented by James Bristow and Henry Atwood, defendants' Exhibit No. 15, is substantially another modification.

I have referred to the original work of Tredgold, upon the steam engine, being the defendants' Exhibit No. 20, but have not
120 been able to identify in that work all the citations called for in the reference. So far, however, as I can judge from the work of Tredgold itself, and from the transcript thereof contained in defendants' Exhibit No. 20, it does not appear to me that the citations made have any important relation to the case in hand. I will, however, reserve to myself the privilege of referring again to the original work of Tredgold, aided by defendants' Exhibit No. 20, which was not at my command before. In "Peclet's Treatise upon Heat," vol. 2d, paragraph 1325 of the 2d, and paragraph 1561 of the 3d edition, page 319, which is now before me, I find the description of a furnace designed for the burning of tobacco stems. It is especially intended for the consumption of tobacco stems which have been previously dried in the air upon hot plates, forming the upper surface of the furnace block. These iron plates, being heated over the flues of the horizontal furnace, in one of the two compartments of which coal or other dry fuel is burned, while in the other are placed the tobacco stems. These being also fired, the smoke from them is brought into a circuitous flue provided for this purpose, where it meets and is consumed by the hot air accompanying the products of combustion from the coal fire. This apparatus is essentially like the furnace of Watt for consuming smoke, also described by Peclet, and noticed in defendants' Exhibit No. 7. The spaces marked in the plan or horizonal section, figure 365, and designated by the letters CC, DD, &c., constitute a mixing chamber, inasmuch as therein the smoky products coming from the imperfect combustion of the tobacco stems are commingled with the gases coming from the hot coal fire. This form of apparatus is only a special case of numerous similar contrivances, which have been in use in the arts since the days of Watt, for the purpose of consuming smoke.

In Karston's book on the Salt Manufacture is the description of a furnace, the details of which are quoted in defendants' Exhibit No.
8, which has an important bearing upon the present contro-
121 versy. Karston recognizes, in order to the more perfect combustion of fuel, and especially of those kinds of fuel which are used in a state of great subdivision or communition, as, for example, of coal dust and the like, the importance of supplying the furnace with a regulated current of air (preferably of heated air), and of a double grate, as in two furnaces placed the one above the other, the lower one to receive small fuel, already in a state of ignition, falling through the grates from the upper fire chamber, but he

does not, so far as I understand his description, recognize or imply the employment in furnaces of this construction of wet fuel, and his description is too general to be considered as an anticipation of the furnace of Thompson. I have not been able to refer to the original text and drawings of Karsten, the tracings from which given in the defendants' Exhibit No. 8, are so obscure that perhaps I do not get his full meaning.*

Int. 5. Could or could not a mechanic, without invention or discovery, from the description contained in the said publications, or any or either of them, construct a Thompson furnace, as described in his patents of March 31st, 1857, and December 15th, 1857, or either of them, and give your reasons for your statements?

A. I conceive not. A mechanic who had for his object the construction of a furnace designed for the successful combustion of wet fuel, such as tan, begasse, &c., and instructed only by the drawings and descriptions to which reference has been made, would fail in his efforts to produce such an apparatus unless he were to call into exercise those combinations which experience alone could give him; combinations the result of which, guided by his experience, constitute, according to the principles of patent law, an invention or discovery. My reasons for this opinion are as follows:

I will assume in the first place that the mechanic who is supposed to have before him the solution of this problem is provided with the drawings of Watt's furnace, described by Peclet in figures 134 and 135 of the 3d edition of his "Treatise upon Heat," being one
122 of the citations in defendants' Exhibit No. 7; he will find there two furnaces placed side by side, and with contrivances for throwing at pleasure the draught from one of these furnaces across the already ignited fuel contained upon the grating of the other. He would find upon feeding one of these furnaces with wet tan, for example, while the other was burning dry fuel, that the condition of the wet fuel furnace would be such that the temperature of the whole would rapidly fall below the point at which a perfect combustion could be maintained in this form of apparatus for any length of time. That, in fact, this form of apparatus was essentially deficient in its essential features for the purpose intended; while as a smoke-consuming furnace for which it was designed by its inventor, the smoke-producing fuel being bituminous coal or wood, for example, its action would be found, as long experience has taught us, entirely satisfactory. This is, in fact, as I have already remarked in a previous answer, the parent form of a considerable number of similar furnaces of substantially identical construction which have been subsequently constructed, and some of them patented as smoke consumers; such, for example, are the English patents of Hall, and of Bristow & Atwood, being defendants' Exhibits Nos. 14 and 15. Such, also, as I understand it, is the boiler furnace described by Tredgold, as cited in defendants' Exhibit No. 20. We will assume next that our mechanic

* The work of Karsten was subsequently produced by witness in court, and his opinion as stated in his testimony confirmed.

is still further assisted in his efforts to solve this problem by reference to the description of Rudler's furnace,* being defendants' Exhibit No. 7, constructed for the purpose of burning tobacco stems. It is obvious from what has already been said in my last preceding answer that this furnace was not intended by its inventor for the combustion of wet fuel, for he provides by a special form of construction in his apparatus for the previous drying out of the water contained in the tobacco stems by exposing them upon a hot surface until they are dried. If it is necessary to employ this previous preparation of the fuel to be
123 consumed before it is fit to be introduced and consumed with success in this form of apparatus, in which, by its construction, a very extended system of flues is provided to insure the complete commingling of the products of combustion from the two furnaces, *a fortiori* would it be essential that a similar preparation of the wet fuel should be provided for in those other forms of smoke-consuming furnaces which are built substantially according to the descriptions of Watt.

So far would our mechanic fail of receiving from the figures and descriptions of the furnaces already cited the instructions which would be essential to his success in the construction of a furnace designed for the consumption of wet fuel, similar to that which is successfully employed in the furnaces built in accordance with the instructions given in the several patents of Moses Thompson.

In the furnace described by Karsten, to which reference has already been made, we find the first hint which would guide a mechanic in the recognition of the very important feature of the combination of two furnaces of combustion, the one placed above the other, and communicating in such a manner that the fuel contained in the upper chamber shall gradually fall into the chamber beneath, corresponding in its position and action to what I have distinguished as the incineration chamber in the furnace of Thompson. I do not, however, perceive from my study of the descriptions and plates of Karsten that his furnace is so designed that a mechanic, guided only by his description and drawing, would be able, without important modifications, to adapt it to the consumption of wet fuel, nor do I find anything in the language of Karsten which justifies the opinion that this author had in view, either in the conception or the description of this furnace, its adaptation to such a use.

If in view of all that we know as the result of many years of experience in the construction of wet fuel furnaces we compare
124 the various contrivances to which reference has been made, with each other, it is certainly possible that an engineer, expert in the business of constructing furnaces, could, by a judicious selection and combination of the several features which he might borrow from these drawings and descriptions, contrive a furnace which should be adapted to the successful combustion of wet fuel; but that a mechanic, without the exercise of the inventive faculty, could, if only instructed by these guides, and without experiment,

* Peclet, vol. ii, (3 ed.,) p. 319.

produce such an apparatus, I do not believe. The records of invention abound with illustrations of the successful combination of various features, borrowed either from other inventions, or familiar in the common experience of life, no one of which, considered by itself, could claim successfully the merit of being a patentable invention, while their combination for a specific purpose, mechanical or otherwise, does form the subject of a valuable patent. This general statement finds abundant confirmation in that very large class of inventions which have for their object the application of heat, and, as I conceive, the furnace which, is the subject of this controversy is the best illustration we could desire of the truth of this general principle of patent law.

Int. 6. Have you examined exhibits now shown you, viz., Complainants' Exhibit Model Finch—Exhibit Model Finch, with the flues taken out and other flues inserted, marked Exhibits Meagley, 1, 2, 3 and 4; Finch No. 2, Defendants' Exhibits 10 and 12, and state what kind of furnaces they are, and whether they do or do not differ in any respect from said furnaces of said Thompson, as described in his said letters patent, or either of them, with your reasons for your answer?

A. I find the model marked Finch, which is now before me, embracing all the features described by Thompson, as constituting in their combination his wet fuel furnace. It has two or more chambers for the reception of wet fuel, and two or more ash pits or incineration chambers, corresponding to the wet fuel chambers. The wet fuel chambers are low arched furnaces, provided each with two feed holes, and with gratings of fire-brick, separating them from the lower combustion chamber. The lower chambers, like the upper, are separated from each other by walls of masonry. The flues from each couple of furnaces are confluent in a common chamber of masonry, discharging upward through a short vertical flue into an enlarged space, above which is placed the boiler, or other object to be heated. These together are the essential features of Thompson's invention, and correspond, substantially, in their details to his drawings and specifications. The differences which are seen in the mode of construction of the mixing chamber, or common space built of masonry, into which the products of combustion arrive, on their way to the object to be heated, are formal differences adapted to the special case in hand, and are not substantial differences. I should say that in all important respects a furnace constructed in accordance with this model marked "Finch" would be indentical with Thompson's furnace.

The exhibit marked model "Finch," as modified by Meagley, Nos. 1, 2, 3, and 4, is identical with the former exhibit as respects the mode of construction of the furnace in all its parts, with the exception of those portions representing the flues, and marked Meagley, 1, 2, 3, 4. The differences here represented are chiefly in the mode of delivery of the products of combustion, which arrive by short ascending flues, inclining backward and upward from each of

the combustion chambers, and delivering into a common rectangular space beneath the boilers, or object to be heated. In this form the furnace like the preceding is substantially the same with the specifications and drawings of Thompson, but the mixing chamber is more circumscribed, and differs from the original drawing of Thompson in that it is surmounted by the boilers, and is not, as was described by him, a masonry chamber, wholly inclosed on all sides by fire-brick, and delivering therefrom by a flue into the space beneath the boiler. With this difference the model is identical with that first described.

126 The furnaces exhibited in the drawing, marked Exhibit "Finch No. 2, Charles S. Hall, U. S. comm'r," appear to me to be designed in full accordance with the specifications of Thompson's patent. The products of combustion from all the furnaces arrive at a common receptacle, which is shown upon the plan to be a square space of masonry, measuring 22 inches in each of its dimensions, and connected with the flues which deliver thereto the products of combustion. Above this cubical space this combustion chamber enlages into a hopper-shaped cavity, also of masonry, conforming to the dimensions of the fire-box of a locomotive steam boiler, which surmounts the whole. With the exception of the formal differences of construction, imposed by its adaption to this special use, I see no difference between this furnace and those of Thompson.

The furnaces represented in Exhibit No. 10, marked Ashley's Exhibit, so far as it is possible to form a correct notion of its construction from so rude a drawing, appears to be substantially like the furnace of Thompson. It exhibits a top view of four furnaces, placed side by side, each having two feed holes, and each represented as having a separate flue of discharge through the masonry in the direction of the boiler, or object to be heated. It is impossible for me to say without further instruction than is afforded by the imperfect sketch before me, whether these furnaces are, or are not, constructed in accordance with specification of Thompson, and without further and more detailed information than the sketch affords, I am unwilling to make any further statement regarding it.

The furnaces which are indicated in the sketch marked Exhibit No. 12, so far as their construction is made evident by the linear outline, are two vaulted spaces having openings, or an opening at the top of each for feeding, with grates separating the fuel chamber from the ash pit. This sketch is presumed to indicate the general construction of Thompson's wet-fuel furnace, but the drawings

127 are too imperfect to enable me to say with any degree of confidence that they are intended to represent a furnace constructed in all important respects in accordance with Thompson's specification. By the plan upon the same sheet, it is evident from the directions indicated by the arrows that each furnace discharges by a somewhat elongated throat into a flue presumed to rise vertically in masonry into a common space, through which it traverses

twice at right angles before arriving at the smoke stack. If this is not the correct description of the mode of action in this furnace, it is the best interpretation which I am able to give of its action, guided only by the diagrams, not having seen the apparatus itself. I am unwilling, without further and more explicit instruction, to give any more definite statement than I have already given respecting the construction and mode of action of this furnace.

Cross-int. 107. Would not a furnace with a single oven and open ash pit, and without a damper in the rear flue, burn wet tan successfully without there being a good body of wet tan, or a good body of carbonaceous fuel in active combustion in the ash pit?

(Objected to as immaterial and too uncertain to call for an opinion.)

A. I think not; I have never seen a furnace of this description in action, unless it be the so-called Crockett furnace, and in that the combustion of wet tan was sluggish and imperfect, and was carried on in that condition only by the use of more or less dry wood.

128 The U. S. Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the files of this office of Moses Thompson's caveat, filed August 12, 1853.—Furnace.

In testimony whereof, I, Samuel S. Fisher, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this twenty-fifth day of May, in the year of our Lord one thousand eight hundred and seventy, and of the Independence of the United States the ninety-fourth.

[L. S.] SAM'L S. FISHER,
Commissioner.

Caveat.

To the Commissioner of Patents:

The petition of Moses Thompson, of the county of Henrico and State of Virginia, respectfully represents:

129 That he has made certain improvements in the furnace for burning tan-bark, saw-dust, sugar-cane, after it has passed through the sugar rollers, commonly called bagasse, and wood or any like fuel, wet or dry, and that he is now engaged in making experiments for the purpose of perfecting the same, preparatory to his applying for letters patent therefor.

He therefore prays that the subjoined description of his invention may be filed as a caveat in the confidential archives of the Patent Office, agreeably to the provisions of the act of Congress in that case made and provided, he having paid twenty dollars into the Treasury of the United States, and otherwise complied with the requirements of said act.

MOSES THOMPSON.

Henrico County, Va., Aug. 10th, 1853.

The aforesaid furnace, for more completely concentrating heat at any given point, thereby consuming more fully all the gases and smoke from fuels described, wet or dry, and creating heat sufficient for to generate steam to run engines, boiling purposes, heating rooms, or other uses required by heat, to be constructed on general principles, as follows:

To consist of two or more burning chambers, varied in size according to the fuel used, and built of brick and mortar or any kind of fire-proof material. Each chamber to sit on two or more ash pits, separate and distinct from each pit, to be overlaid with iron grates that will form part of the bottom of the burning chamber, and each ash pit with sufficient space of grate surface to let through the grate a quantity of air necessary to carry on the combustion of fuels of different kinds required to be consumed for any given purpose at one time.

Each ash pit to be connected to one large ash pit or air receiver, that supplies each ash pit with its air for the burning chamber,
130 and receives all the heated ashes and coals, when there is a surplus in the small ash pits, thus saving all the heated air from this deposit, passing forward through the smaller pits into the burning chambers.

The said chambers are to be connected with the place where the heat is to be applied, by a flue for the current from the burning chambers to pass to the place of application—said flue to be constructed on the side of the burning chambers and connected with each chamber; said flue to be a size according to the amount of heat or fire to be conducted from the said chamber, and a damper or valve at the outlet of each chamber.

Each chamber to have a door in front to open, to stir the fires and kindle when suffered to go, out and to be used as a feeder where wood is used.

When tan-bark, saw-dust, or similar fuel is to be used, there are to be holes left in the top of the burning chambers for feeders after the fire is kindled on the grate, the feeders opened, the fuel runs through the feeders, on the fire below each feeder, forms its sliding pile; as fast as it burns away at the bottom each pile continues caving down on the fire. The fuel is dumped on top of the chamber. For burning bagasse there is to be a trap-door on the top of each chamber as a receiver and feeder; said doors made of iron, hung with the hinges fastened with a spring-latch, so when the fire is kindled in the chamber and quantity of fuel deposited on the receiver, the spring loosens, the weight of the fuel swings down the door and slides below onto the fire, and when the feeder is relieved of its load, it being so balanced, swings back and fastens itself again.

This system of furnace combines the principles of air-tight, and the burning by draught or blower, by having all of the dampers or valves closed at the inlet from the air receiver into the small ash pits, and all the dampers or valves in the flue leading from the burning chambers to where the heat is used, closed, except one damper of the

small ash pit, and the damper at the outlet of the chamber
131 over the same pit, for draught or blower system, meaning to let in sufficient current of air to be concentrated upon that point of the grate, to make whatever combustion is wanted to supply any given quantity of heat.

Also to have a damper in the chimney beyond where the heat is to be applied, to regulate and save heat, by preventing too strong a current to pass out of the chimney for the amount of combustion.

The arrangement of the furnace and the arrangement of the burning chambers, ash pits, and air-receiver so as to burn the different kinds of wet or dry trashy fuel, with economy in tending and economy in quantity of fuel to be used, by heating the fuel to a high temperature on the air-tight system, and then by the application of air into the burning chambers by first opening through one ash pit and then change to another, and each chamber having its turn to be the fuel heating and its turn in fuel burning.

Thus having a constant supply of heated fuel on hand in said chambers, and by concentrating the currents of air in the burning chamber, so as to raise the burning temperature so high as to more completely consume the smoke, gases, and steam arising from the fuel, and by this improvement make use of the wet and trashy fuels that in many cases are an incumbrance, to be moved away at an expense, which is used by this system, and thus saving other fuel.

To more completely define what I claim in the aforesaid description as new invention is the combination, arrangement, and construction of the burning chambers, ash pits, flues, dampers or valves, &c., as before described, and the arrangement of heating of the fuel on the air-tight system, and the combustion to draught or blower through the ash pits into the burning chambers, as before described, and using or reserving the heat in the burning chambers at option, to be used at any given place required.

Economy in tending fire and using the aforesaid described
132 fuels usefully and more completely burning the smoke and gases from said fuels, after being decomposed by heat. I also claim the large ash pit or air receiver, and bagasse receiver or feeder to the burning chambers. I disclaim the invention of the dampers or valves, tan or sawdust feeder, or doors for feeding wood, and the air-tight system, draught or blower system in their separate capacity is generally understood.

STATE OF VIRGINIA,
City of Richmond, } *to wit.*

On this 15th day of August, 1853, before me, the subscriber, a justice of the peace for said city, personally the within named, appeared Moses Thompson, and made solemn oath that he verily believes himself to be the original and first inventor of the mode herein described for a furnace for the burning of tan-bark, sawdust, wood,

bagasse, and that he does not know or believe the same was ever before known or used, and that is a citizen of the United States.

JOS. C. WINGFIELD,
Justice of the Peace.

THE U. S. PATENT OFFICE.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the records of this office of the reissued letters patent granted Moses Thompson March 31st, 1857, No. 446.

In testimony whereof, I, T. C. Theaker, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed this fourth day of January, in the year of our Lord one thousand eight hundred and sixty-six, and of the Independence of the United States the ninetieth.

[L. S.] T. C. THEAKER.

133 THE UNITED STATES OF AMERICA.

To all to whom these letters patent shall come:

Whereas Moses Thompson, of New York, N. Y., has alleged that he has invented a new and useful improvement in furnaces for burning wet fuel—

(For which letters patent were issued to him, dated 10th April, 1855, the same surrendered, canceled, and new letters were issued to him, dated 7th October, 1856, and said last letters having been surrendered by him, the same have been canceled and new letters ordered to issue to him on his second amended specification.)

Which he states has not been known or used before his application; has made oath that he is a citizen of the United States; that he does verily believe that he is the original and first inventor or discoverer of the said improvement, and that the same hath not, to the best of his knowledge and belief, been previously known or used; has paid into the Treasury of the United States the sum of fifteen dollars, and presented a petition to the Commissioner of Patents signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose:

These are, therefore, to grant, according to law, to the said Moses Thompson, his heirs, administrators, or assigns, for the term of fourteen years from the said tenth day of April, one thousand eight hundred and fifty-five, the full and exclusive right and liberty of making, constructing, using, and vending to others to be used the said improvement, a description whereof is given in the words of the said Thompson in the schedule hereunto annexed and is made part of these presents.

134 In testimony whereof I have caused these letters to be made patent, and the seal of the Patent Office has been hereunto affixed.

Given under my hand, at the city of Washington, this thirty-first day of March, in the year of our Lord one thousand eight hundred and fifty-seven, and of the Independence of the United States of America the eighty-first.

[L. S.] JACOB THOMPSON,
Secretary of the Interior.

Countersigned and sealed with the seal of the Patent Office.

J. HOLT,
Commissioner of Patents.

The schedule referred to in these letters patent and making part of the same.

To whom it may concern:

Be it known that I, Moses Thompson, formerly of Henrico county and state of Virginia, and more recently of New Orleans, in the state of Louisiana, but now of the city and state of New York, have invented new and useful improvements in burning tan-bark, bagasse, saw-dust, and other kinds of fuel, in a wet state, for the purpose of creating heat to generate steam, or to be employed in heating or drying operations; and I hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings forming part of this specification, in which Fig. 1 is a horizontal section of a furnace constructed according to my invention. Fig. 2 is a vertical section of the same in a line *x y* of Fig. 1.

Similar letters of reference indicate corresponding parts in the several figures.

The main object of my invention is to effect the more economical use for fuel, of tan-bark, bagasse, or other trashy matter, in a wet state, or very green or wet wood.

135 To enable others skilled in the art to understand and use my invention, I will proceed to describe its construction and operation. The furnace shown in the drawing has three fire chambers, A A′ A″; three is the number shown, as I consider that number, in many cases, to be best adapted to practical operation. In some cases two may be sufficient, and in others more or less. In making these variations as to the number of chambers the builder is to be guided by the quantity of heat required, size of chambers, and character of fuel to be used.

The fire chambers are of a square, but may be of other form, with grate bottoms, B B′ B″, and arched tops, or said tops may be used or built of any other form adapted to the kind of fuel to be used. They are separated by a wall of fire-proof material and lined throughout with fire-brick, and in case of burning wet tan or bagasse, fire

brick grates should be used. Each burning chamber is provided with a door, C, in front, for the purpose of lighting and tending the fire, with an opening, D, at the top, for the purpose of supplying fuel, and with an opening, E, at the back end of the chamber, which leads to the flue, F, or the mixing chamber. The opening may be provided with a damper, K; each fire chamber has a separate ash pit, G, below it, which is furnished with a door, H, to regulate the admission of air.

The flue or mixing chamber, F, extends across the back of all the three fire chambers, and the chimney may be at one end, or may be placed in the rear, with the flue I leading to it from the flue F. If the furnace is used for generating steam the best place for the boilers will be in flue I, which will be made of a proper size to receive and nearly surround it. If used for other purposes any arrangement may be made best adapted to the application of said heat. The thing to be heated ought to be placed a little above the inside top of the mixing chambers. The current from the mixing chamber, in passing to the place of use, should descend or pass under a bridge to the place of use equal to about one-half of the depth of the mixing chamber, then rise to the place of use.

136 In case of nearly dry fuel, such as green wood and sawdust, the current should rise, immediately after leaving the burning chamber, through the mixing chamber to the place of use, and the flue, E, leading out of the fuel chamber, A, into the flue or mixing chamber, F, should be increased to about threefold capacity of that used for very wet fuels, to be varied in proportion to the wetness or dryness of said fuels. In case of burning of sawdast or green or wet wood, the chamber should be about double the grate surface of what is commonly used for burning of wood to accomplish the same object; but for burning wet tan it should be increased to about fourfold, and in case of burning bagasse it should be increased about sixfold, and the height of the chamber increased so that the grate may be covered by feeding at the top.

The mode of conducting the operation of the furnace is as follows: Fires being lighted in all of the fire chambers with dry fuel, and the masonry heated to a high degree, two of the three chambers, A A, are fed with wet fuel and have their ash pits closed and the dampers, K K, partially closed, though this latter is not absolutely necessary. The other fire chamber having its charge partially dry in the meantime, has the damper, K, opened, and the door of the ash pit, H, opened far enough to admit any quantity of air which may be required to promote such a degree of combustion as may be necessary to generate the amount of heat required. There should be no artificial blast, and if a high stack be used there should be a damper in it to moderate the draft.

When the fuel in the open chamber is reduced to a desirable degree its ash pit is closed and the chamber recharged and another opened and supplied with air until the fuel within is reduced, when it is closed, recharged, and another opened, each in its turn being

opened and supplied with air to generate and supply the requisite amount of heat and carbonaceous gases, while the others are
137 closed and successively supplied with fresh fuel to heat and decompose the same to such a degree as is desirable, before allowing rapid combustion to take place. Each fire chamber should be supplied successively with fuel at proper intervals by any convenient means—either through the hole, D, or door, C, in front.

The principal advantage of a furnace and process of this description consists in heating the wet charge without unnecessary waste of heat, decomposing it into such gases as will, when mingled in the mixing chamber with the products of combustion from the active chamber, cause the most perfect combustion of the gases and smoke to be effected.

This perfect combustion could not be effected in a single fire chamber, but when two or more fire chambers are employed, no interruption takes place, and the object is readily attained.

Another advantage consists in always holding a certain quantity of heat and highly heated fuel in reserve in the closed chambers, which may be immediately brought into action by opening one or more of the chambers. A similar but inferior result might be produced by having several grates and ash pits to the same fire chamber, each grate charged successively, and its ash pit for the time closed immediately after fresh charging, to exclude the air. I have described this in my caveat on which my application is based, but do not use it because of its inferiority in practice, although it involves my principle.

After ample experiments, I have discovered that any results which can be produced by the use of dry fuel are inferior to wet, in proportion to quantity used, and that results like mine can only be attained by the use of wet fuel, similar to what I have herein mentioned, fed into an intensely heated chamber; under such circumstances the water in the fuel in the presence of the carbonaceous substances in the furnace will be decomposed, giving its oxygen to the carbonaceous matter, dispensing with a draft, and its cooling and waste-
138 ful influence, and rendering the combustion so perfect that no smoke is visible.

In burning tan and saw-dust, where a large quantity of heat is to be made, in order to save the mere use of their number, I put the chambers in twice as long as wide, and use two openings, D, to feed through, and thereby accomplish double to each chamber. I do not claim the within-described arrangement of a series of fire chambers to communicate with one common flue, irrespective of the purpose for which and the manner in which I employ the said arrangement; but what I do claim as my invention, and desire to secure by letters patent, is—

Using green bagasse, wet tan, wet saw-dust, and other wet carbonaceous or vegetable substances, as fuel for the production of intense heat, by mingling the gases issuing from a highly-heated mass thereof with those arising from carbonaceous combustion by the in-

tervention of a flue or chamber, with which the chamber or chambers containing the fire and charge of wet substances communicate, and in which said gases meet, mingle and consume each other on their way to the apparatus to be heated, and to the stack. And I also claim the combustion, for the purposes of a high degree of heat, of bagasse, refuse tan, saw-dust, and other wet refuse substances, or very wet and green wood, by the employment of a series of fire chambers arranged in any manner substantially as described, to communicate with one common flue or mixing chamber, when any number of said chambers are nearly closed to the admission of air when first charged as described, whilst the remaining chamber or chambers is in full communication with the mixing chamber, and has a proper supply of air admitted, and the ash pit of each chamber in its turn is nearly closed and then opened and has air admitted, whereby the heat required is rendered continuous and comparatively uniform, while the fuel in some of the chambers is being heated and decomposed, and its
139 gases sent forward to the mixing chamber to any desirable degree, as herein set forth.

MOSES THOMPSON.

Witness:
JOHN J. MURRAY,
HENRY FARRINGTON.

Extension.

Whereas, upon the petition of Aaron Woodman, of New York, N. Y., administrator of the estate of Moses Thompson, deceased, for the extension of the patent granted to said Moses Thompson, April 10, 1855, reissued October 7, 1856, and again reissued March 31, 1857, the undersigned, in accordance with the 18th section of the act of Congress, approved the 4th day of July, 1836, entitled "An act to promote the progress of the useful arts, and to repeal all acts and parts of acts heretofore made for that purpose," and the act approved the 27th day of May, 1848, entitled "An act to provide additional examiners in the Patent Office, and for other purposes," did, on this 8th day of April, 1869, decide that said patent ought to be extended:

Now, therefore, I, Elisha Foote, Commissioner of Patents, by virtue of the power vested in me by said acts of Congress, do renew and extend the said patent, and certify that the same is hereby extended for the term of seven years from and after the expiration of the first term, viz., from the 10th day of April, 1869, which certificate being duly entered of record in the Patent Office, the said patent has now the same effect in law as though the same had been originally granted for the term of twenty-one years. And it appearing from evidence on file in this office that the original of said last
140 reissued patent cannot now be produced, it is directed tha this certificate of extension be entered on a certified copy o said last reissued patent.

In testimony whereof, I have caused the seal of the Patent Office to be hereunto affixed this 8th day of April, 1869, and of the Independence of the United States the ninety-third.

[L. S.] ELISHA FOOTE,
Commissioner.

Fig. 1

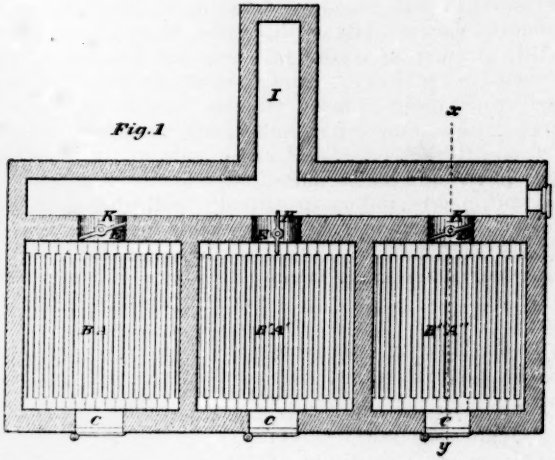
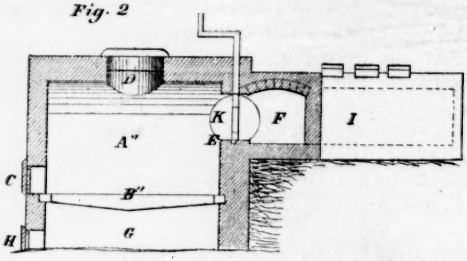


Fig. 2



141 The U. S. Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the records of this office of the letters patent granted Moses Thompson, December 15, 1857.—No. 18874.

In testimony whereof, I, D. P. Holloway, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto

affixed, this thirteenth day of May, in the year of our Lord one thousand eight hundred and sixty-five, and of the Independence of of the United States the eighty-ninth.

[L. S.] D. P. HOLLOWAY.

No. 18874.—THE UNITED STATES OF AMERICA.

To all to whom these letters patent shall come:

Whereas Moses Thompson, of New York, N. Y., has alleged he has invented a new and useful improvement in bagasse furnaces, which he states has not been known or used before his application; has made oath that he is a citizen of the United States; that he does verily believe that he is the original and first inventor or discoverer of the said improvement, and that the same hath not, to the best of his knowledge and belief, been previously known or used; has paid into the treasury of the United States the sum of thirty dollars, and presented a petition to the Commissioner of Patents, signifying a desire of obtaining an exclusive property in the said improvement, and praying that a patent may be granted for that purpose:

142 These are therefore to grant, according to law, to the said Moses Thompson, his heirs, administrators, or assigns, for the term of fourteen years from the fifteenth day of December, one thousand eight hundred and fifty-seven, the full and exclusive right and liberty of making, constructing, using, and vending to others to be used the said improvement, a description whereof is given in the words of the said Moses Thompson in the schedule hereunto annexed, and is made part of these presents.

In testimony whereof, I have caused these letters to be made patent, and the seal of the Patent Office has been hereunto affixed. Given under my hand, at the city of Washington, this fifteenth day of December, in the year of our Lord one thousand eight hundred and fifty-seven, and of the Independence of the United States of America the eighty-second.

[L. S.] JACOB THOMPSON,
Secretary of the Interior.

Countersigned and sealed with the seal of the Patent Office.

J. HOLT,
Commissioner of Patents.

The schedule referred to in these letter patents, and making part of the same.

To all whom it may concern:

Know ye that I, Moses Thompson late of New Orleans, Louisiana, but now of the city, county, and state of New York, have invented new and useful improvements in furnaces for using as fuel bagasse,

wet tan, and other carbonaceous substances, too wet to be
143 conveniently burned in the usual way, of which the following is a full and exact description, reference being had to the accompanying drawings, making a part thereof, in which—

Fig. 1 is a front view of my furnace.

Fig. 2 is a sectional side view, showing the interior thereof and the charge of wet fuel, &c.

Fig. 3 is a front sectional view.

Fig. 4 is a horizontal view of the grate.

Fig. 5 is a sectional perspective view of the interior, showing the corrugations, &c., in the wet-fuel chamber.

The same parts are designated by the same letters on all the figures.

The leading object of my invention is to use, as far as possible, the hot vapors driven out of the wet mass while drying, instead of cold, common air, to support and complete the combustion of the carbonaceous portions of the wet fuel.

Bagasse and other wet fuel might be advantageously burned in one furnace, but results are much more uniform and reliable when two are used discharging their gases into a common mixing chamber, and I therefore prefer to use two or more.

The grate surface and the height of the furnace should be regulated according to the kind and wetness of the fuel; the wetter the fuel the larger the furnace, and the smaller the mixing chamber should be. To burn bagasse for making ten or twelve hogsheads of sugar per day, I make my furnaces each about ten feet square and twenty-two feet high. For making greater or smaller quantities of sugar, I increase or diminish the size of the furnace; but for making smaller quantities the size of the furnace should diminish in a less proportion than the quantity of sugar, and for larger quantities the size should increase in a less proportion than the quantity of sugar.

For burning refuse tan and saw-dust I think it better to make the furnace longer and narrower, with two fuel openings on the
144 top; and for a furnace five feet wide and ten feet long, I would make the height from the bottom of the fire chamber to the top of the wet-fuel chamber about five feet.

The bottom of the grate I would place about two feet above the hearth. But wet fuels differ so much in character and wetness that it is impossible to give precise dimensions.

The furnace I propose to describe is particularly calculated to consume bagasse.

"I build two furnaces side by side, each nearly square in its horizontal section. Towards the top I draw in the wall in such manner as to form a kind of dome with a sufficient opening at top to feed the bagasse. The outer walls of these furnaces should be from 24 to 30 inches thick, and built with a special view to rendering them non-conducting; the wall near the top and the partition between the two furnaces may be thinner. In each furnace chamber there should be a partition of fire-brick extending across it from front to back and

rising nearly to the top, dividing it into two nearly equal parts. The whole interior of the furnace should be of fire brick. The main chamber of each furnace should be divided into two parts—upper and lower—by a fire-brick grate about one-fifth the height of the furnace above the hearth, the back end of the grate being a little lower than the front. The bottom of the lower chamber may be a grate with an ash-pit, but a hearth is much better.

In each furnace at the front, on each side of the central partition and immediately under the front end of the grate, should be doors for feeding wood or other dry fuel, and directly under these doors at the hearth of the lower chamber should be draught openings capable of adjustment, to support combustion in the lower chamber.

Extending across the back of both furnaces, and opening into both by flues, is a mixing chamber into which all the gases from both furnaces enter in a highly-heated state and mix and consume each other on their way to the boiler and stack. This chamber should be about one-half the capacity of all the fire chambers, and it should extend down about as low as the back end of the grate. The flue through which the products of combustion pass out of this chamber and under the boiler should be in section about one square foot to forty cubic feet of mixing chamber.

The feed openings at the top of the furnaces should be closed by doors which open inwards by the weight of the feed, but are self-closing, and do not yield to pressure from within.

The sides of the interior of the upper or wet fuel chamber or drying chamber of the furnace, except the front and back, are corrugated up and down, as also the sides of the central walls or partitions, as shown in fig. 5, the corrugations extending down to the grate; these corrugations are for the purpose of allowing the heat to radiate upwards from the fire chamber for heating the masonry and the wet charge, while the gases or vapors driven out of the wet charge by the heat are allowed to descend to the fire chamber or the mixing chamber. If the surfaces of this masonry were smooth, the bagasse would lie against them in such a manner as to obstruct the upward radiation of the heat and the downward passage of the vapors.

These corrugations are unnecessary in burning tan and sawdust.

The spaces between the grate bars for burning bagasse should be about six inches wide for the finest grinding and twenty inches for the coarsest, and should vary between these widths according to the fineness of grinding, but for sawdust and tan much less, say from one inch to ¾ of an inch. The grate should be made of fire-brick.

The operation of my furnace is as follows: A hot fire of dry fuel is kindled in the lower or fire chambers of the furnaces, and after it has been continued till the masonry is well heated, the chamber above the grate is fed with the bagasse or other wet fuel. This hot fire in the fire chamber, especially towards the front of it under the principal mass of the wet fuel, must be preserved throughout the operation. The heat from the masonry and the fire

chamber will be communicated to the wet fuel, which will cause steam and other gases to issue from it and mix with the intensely hot gases of combustion from the fire chamber, and in a short time the mixing chamber will present intense combustion and heat, the dampers of the fire chambers being partially closed. The lower part of the wet charge will by degrees become dry and charred and will fall through the grate prepared as above into the fire chamber and supply or nearly supply the place of other dry fuel in preserving the fire in this chamber, and the wet fuel being from time to time supplied will furnish in a highly heated state aqueous vapors which, descending through the corrugations and otherwise into the fire chamber and mixing chamber, will be decomposed, furnishing much oxygen to the fire, and supply the oxygen necessary to complete in the mixing chamber the combustion of all the combustible gases issuing from the fire chamber. If, by accident, the fire in the lower part of the furnace should predominate, the draught should be diminished and more wet fuel added, and if, by accident, the fire in the fire chamber should become too much cooled down, the draught should be let on, and any deficiency of dry fuel should be supplied to the fire chamber. Under proper management, little or no dry fuel need be fed to the fire chamber after the operation is fairly commenced, the charred matter falling through the open grate will supply its place; and the caloric thus produced by the combustion of wet fuel will be vastly greater than from the same quantity by measure of the same fuel when dry. In the fire chamber and in the mixing chamber under intense heat, the carbonaceous gases will decompose the steam from the wet fuel and effect complete combustion.

When the operation is fairly commenced, if the water in the wet charge amounts to say fifty per cent. by weight of the fuel,
147 the dampers of the fire chambers should be nearly or quite closed to exclude the air; vapor from the wet charge will then descend through the corrugations and otherwise into the fire chambers and support the combustion therein, while other portions of the vapor will enter the mixing chamber and complete the combustion there. If the fuel, however, contains much smaller quantities of water, more air in proportion should be admitted at the damper, the object being to admit no more air than will supply the deficiency of the vapor.

In the drawings, D represents the chambers for the dry fuel, W those for the wet, M the mixing chamber, the dotted line *m* limits it for the wettest bagasse, P the partition, F the feed openings for the wet fuel with their doors, C the corrugations, A the openings for draught, F doors for feeding dry wood, B the boiler, *b* the bridge, and A the ash pit beyond the bridge. Little, if any, of the boiler should extend over the mixing chamber. If any considerable portion of the mixing chamber is covered by the boiler, its cooling influence will prevent the decomposition of the vapor and defeat the object of my invention. Great care should be observed in giving proper dimensions to the mixing chamber, for the perfection of the

combustion and the efficiency of the furnace depend greatly upon it. The principal object of this chamber is to give the combustible carbonaceous gases from the fire and the aqueous gases from the mass of wet fuel an opportunity of mingling together in such a manner and under such circumstances that the aqueous vapor will be decomposed by the carbonaceous gases, and its oxygen given out to complete the combustion of the carbon, without the introduction of air into the mixing chamber, thus saving the caloric previously communicated to the wet charge, while drying it and charring its lower portions, and avoiding the cooling influences of cold air. This can take place effectually only in the presence of a high degree of heat and in the absence of a supply of free oxygen. If this chamber be too small to receive these gases as fast as the furnace is able to produce them, the operation will of course be choked and im-
148 peded. If the chamber is larger than can be kept densely filled with these gases, of course atmospheric air will be found there at the commencement, and will continue to find its way into the chamber, and while atmospheric air is present, the carbonaceous gases will take its oxygen from that principally instead of decomposing the steam, and the heat in the chamber will be much diminished and the large quantity of nitrogen $\frac{4}{5}$ contained in the air, which is neither a combustible nor a supporter of combustion, will at once greatly increase the volume of gases to be sent forward to the stack and proportionably decrease its temperature, and when the chamber becomes very large the cooling influences become so great that combustion will immediately cease, and smoke mingled with steam, oxygen, and nitrogen, will go forward, thus wasting the fuel and imparting only a faint degree of heat to the boiler.

I have therefore fixed the size of the mixing chamber by many careful experiments—and that given above will produce the desired effect with wet bagasse. For dryer fuels furnishing less vapor the mixing chamber should be proportionably increased in size to supply the deficiency with air and to effect complete combustion. Rules more precise would be inconsistent with the nature of the subject.

A large and hot fire should always be preserved in the fire chamber below the grate, and directly under the charge of wet fuel, for the purpose of driving the vapor out of it and charring its lower portion—and the grate is left much more open than in furnaces for burning dry fuel of the same size, for the purpose of allowing the charred portions of the wet charge to fall through to supply fuel for this fire as fast as it becomes fit for that purpose, thus consuming the mass with little or no expenditure of other fuel.

What I claim as my improvement in furnaces for burning bagasse and other fuels too wet to be conveniently burned in the usual way and well known ways is:

149 First, the combination of two chambers, the one above the other, and separated by a grate, the lower one for the combustion of any known dry carbonaceous fuel, and the upper one in immediate proximity therewith to receive heat therefrom for heat-

ing and drying the charge of wet fuel, with a mixing chamber, into which both continuously and simultaneously discharge their gases before reaching the thing to be heated, for mingling and mutual combustion.

I also claim in combination with said fire chamber and wet fuel chamber or drying chamber making the grate upon which the wet charge rests sufficiently open to allow the lower portion of the wet charge as it becomes dried and charred to fall through into the fire chamber and keep a hot fire therein, supplying the place of other dry fuel, while the uncharred portion of the wet fuel is properly supported by the grate till dried as described.

I also claim placing the mixing chamber of combustion in substantially the same position described relatively to the fire, and the wet charge, so that the products of combustion from the dry fuel may pass along the lower part of the wet charge, drying and charring it on their way to the mixing chamber, and reach it without being in any considerable degree obstructed or cooled by the wet charge, substantially as shown.

I wish it distinctly understood that I make no claim to any of the parts or combination above specified, except in their application to the preparation and combustion of wet fuels."

MOSES THOMPSON.

Witnesses:

WILLIAM H. WILCOX.
JOHN J. MURRAY.

Certificate of Extension.

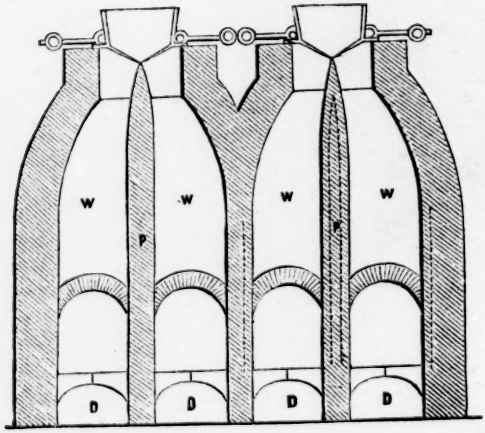
Whereas, upon the petition of Charles N. Black, of New York, New York, administrator *de bonis non* of the estate of Moses Thompson, deceased, for the extension of the patent granted to said Moses Thompson, December 15th, 1857, for an "Improvement in Bagasse Furnaces," the undersigned, in accordance with the act of Congress approved the 8th day of July, 1870, entitled "An act to revise, consolidate, and amend the statutes relating to patents and copyrights," did, on this fourteenth day of December, 1871, decide that said patent ought to be extended:

Now, therefore, I, Mortimer D. Leggett, Commissioner of Patents, by virtue of the power vested in me by said act of Congress, do renew and extend the said patent, and certify that the same is hereby extended for the term of seven years from and after the expiration of the first term, viz., from the fifteenth day of December, 1871, which certificate being duly entered of record in the Patent Office, the said patent has now the same effect in law as though the same had been originally granted for the term of twenty-one years.

And it is hereby ordered that this certificate of extension be entered on a certified copy of said patent.

In testimony whereof, I have caused the seal of the Patent Office

4.



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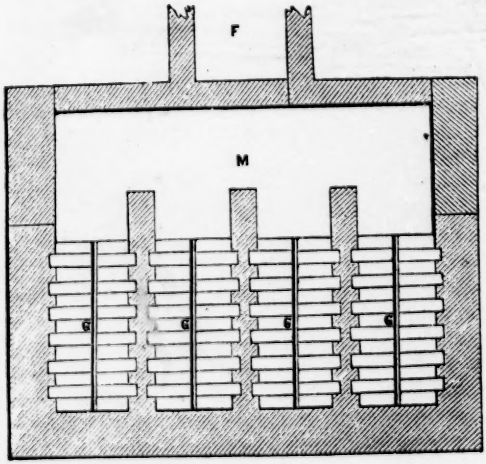

to be hereunto affixed this fourteenth day of December, 1871, and of the Independence of the United States the ninety-sixth.

[SEAL.] M. D. LEGGETT,
Commissioner.

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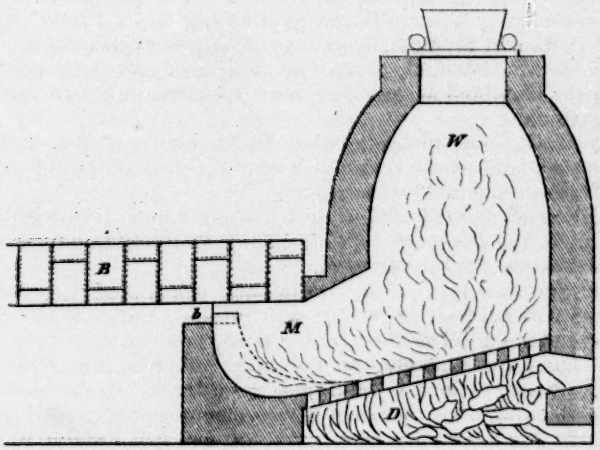


152 *Oct.* 25, 1871.

Met pursuant to adjournment.

Present: Charles N. Black, complainant in person, and Andrew J. Todd, counsel for the defendants, and proceeded with the taking of evidence on the part of the complainant.

WILLIAM H. PLUMB, called and sworn as a witness on the part of the complainant, deposes and says:

Question 1. What is your age, residence, and occupation?

Answer. I am forty-five years of age; reside in Brooklyn; am consulting and constructing engineer.

Q. 2. How long have you been engaged in that capacity, and with whom and under what circumstances?

A. I entered the Novelty Iron Works, New York, in 1843, and served my time, seven years, after which I was assistant engineer on the steamer *Artic*, Collins' Line; on my return I was engaged as mining engineer for H. Bradford; some months after that I entered Union College, Schenectady, as a university student; on my return to New York I was engaged again to H. Bradford, as engineer, and continued with him for several years; during this time I was also

engaged as consulting engineer for the Bristol Copper Mines, Connecticut; on the formation of the new company in 1856, called The Bristol Mining Co., I was engaged as their consulting engineer, and remained with them till the summer of 1857; I continued in the mining business as engineer for several years, and in 1865 I was appointed by the government to take charge as one of a corps of engineers on experiments on combustion at the Brooklyn Navy Yard, in the capactity of and under pay as chief engineer; I have devoted a great portion of my time, meanwhile, to experiments on combustion of various kinds of fuel; since that time, and up to the present, I have been identified as engineer with the iron and coal region of Pennsylvania.

Q. 3. Are you acquainted with Moses Thompson, and if so,
153 when and where, and under what circumstances did you become acquainted with him?

A. I was acquainted with him; I first met him at the Bristol Copper Mine in the summer of 1857; he was then building furnaces for the purpose of burning wet peat.

Q. 4. State whether or not you became acquainted with the construction and mode of operating that furnace, and whether or not you ever made a drawing of it, and if so, produce it?

A. Thompson explained to me very minutely the manner in which he built the furnace, and also how it was to be worked; I made a drawing of it by actual measurement several years after it was built; the drawing is now produced, marked Exhibit B. S. No. 2.

Q. 5. Have you ever examined or built or operated a furnace for burning wet fuel, as described in the patent of Moses Thompson, reissued March 31, 1857, and marked Complainants' Exhibit G, and shown by the model marked E, and if so, state the same?

A. I have examined several furnaces in various parts of the country for burning wet tan, built similar to the model Exhibit E; I have also built at Saxonville, Mass., a furnace for burning wet peat, in the year 1865, which was exactly in size and proportions like the one built at Bristol in 1857; I have furnished plans and have superintended in part the erection of furnaces for burning wet tan; I have also worked them personally.

Q. 6. State what process of feeding these furnaces you adopt when working them.

A. In feeding I was governed by the instructions of Thompson in his reissued patent of March 31, 1857; but for my own satisfaction I operated them differently; such as feeding irregularly the charge of fuel, keeping the ash-pit doors open, or the lower chamber doors open, feeding the charge of fuel at various intervals of time.

Q. 7. What process in practice did you find to operate best in feeding these furnaces?

154 A. I did my best work when I followed explicitly his instructions, such as feeding the fuel alternately, about every half

hour, and closing and opening to a certain degree the doors to the lower chambers.

Q. 8. Are you acquainted from personal examination with the construction, operation, and manner of using the so-called Crockett and Morrison furnaces as described in the exhibits marked Defendants' Exhibits 5, 6, 9, 13, Morrison and Morrison, No. 2, and if so, state the same, and where you have seen such furnace and its operation?

A. I know the Morrison furnace from the exhibits only; I know the Crockett furnace from the exhibit marked No. 6, and also the so-called Crockett furnace, at Swazey, Cooper & Co.'s, at Sparrowbush, N. Y. The latter furnace I have seen in operation. In the first place a certain quantity of dry tan-bark is provided convenient at hand for the engineer, the quantity depending altogether on the state of the draught or weather. The wet tan for combustion is taken immediately from the leaches by cars, and run along over the fire-pit and dumped ready for use; when the engineer fires, which is done in front of the furnaces, of which there are two, each having a grate surface of four feet by six, he shovels a quantity of the dry bark on top of the wet, and then throws into the furnaces as he charges them, first the dry bark, after that whatever mixture there may be of the two, and the remainder of the charge of wet tan-bark; that is their regular practice when they don't use wood.

Q. 12. Have you ever tested the economical working of the furnace at Sparrowbush; if so, state fully what you did in that respect and what results were found from such tests and when you made the same?

155 A. On October 20, 1871, I tested the furnace at Sparrowbush from half-past six in the morning to three o'clock in the afternoon; there were eleven cords of wet tan-bark deposited to the furnaces for use; at half-past six in the morning there was a cord of dry tan-bark deposited, and another cord of dry tan-bark again at 12 M.; I timed the evaporation of water from 8.30 A. M. to 3P. M.; there was 21,035 lbs. of water evaporated at 52 lbs. of steam pressure, with six cords of wet tan-bark, and 1½ cords of dry tan-bark, making 2,804 lbs. water evaporated to one cord of tan-bark used in the manner referred to in my answer to the eighth interrogatory.

Q. 13. Have you ever tested the economical working of a furnace built in the manner described by Thompson in his reissued patent of March 31, 1857; if so, state fully what you did in making such test, and what results were produced, and state the manner of working such furnace when the test was made; what kind of fuel was used, and when and where such furnace was located, and if you made such test in more than one furnace, state such facts in reference to each?

(Same objection continued.)

A. On July 31, 1866, at the Edgeworth tannery, near Malden, Mass., I operated two furnaces, the products of combustion of which were applied to a tubular boiler. The furnaces were operated ex-

actly in accordance with the instructions of Thompson, alternating the feed, closing the ash-pit doors, and opening them at intervals, and in twelve hours we evaporated 18,626 lbs. of water, with two cords of wet tan-bark direct from the leaches—no other fuel was used—making an evaporation of 9,313 lbs. of water to one cord of tan-bark.

At Saxonville, September 25, 1865, furnace constructed similar to one at Bristol copper mines, four chambers each. One fuel hole to each, connected at the back with an arched flue, into which all the products of combustion emptied; fed the fuel alternately, controlled the lower chamber doors as to draft, the fuel being put
156 in every half hour. There was evaporated in twenty-four hours 45,000 lbs of water, with eight cords of peat, containing 65 per cent. of water, equal to the work of 2,240 lbs. of coal, with $3\frac{1}{5}$ cords of peat as tested with coal, the feed water being the same temperature.

One of these furnaces was stopped off from the remaining three, October 2d; with the three remaining furnaces $4\frac{1}{2}$ cords of peat and $62\frac{1}{2}$ per cent. of water was burned in twenty-four hours, and evaporated 30,400 lbs. of water.

The third trial made there were but two furnaces used, and worked twelve hours. The first eight hours a solid quality of peat was used, containing fifty per cent. of water. The last four hours of the experiment an inferior peat was used, and there was 12,762 lbs. of water evaporated and $1\frac{56}{100}$ cords of peat burned, being equal to the work of 2,240 lbs. of coal with $2\frac{1}{5}$ cords of peat.

Adjourned to 12 M., October 26th, same place.

OCTOBER 26, 1871, 12 M.

Met pursuant to adjournment; parties present as before.

Q. 14. What pressure of steam was carried at each of the three places when these tests were made by you as you have stated?

(Same objection continued.)

A. The highest pressure of steam reached at Sparrowbush was 55 lbs. to the square inch as shown by the guage. It went down as low as 48 lbs., and was most of the time about 50 lbs. In my estimate I place it at 52 lbs.

In my test at Saxonville the pressure was constant at 90 lbs., and at the Edgeworth tannery it was 70 lbs.

Q. 15. Did you ever run either of the furnaces you alluded to in any other manner than as you have stated; if so, in what manner, and with what results?

(Same objection continued.)

A. At Saxonville I run the furnaces for several days and
157 nights with the lower chamber doors entirely closed. I did good work, but not equal to the work when performed by opening and closing the chamber doors according to the charges of fuel.

Q. 16. Did you observe the process of drying the tan at Sparrowbush when you was there, how they preserve it, and the quantity of dry tan on hand? If so, state.

(Same objection continued.)

A. I noticed a place for drying tan-bark and a man with a wooden hoe working it over preparing it for drying; I also noticed they had very nearly 200 cords of dry tan-bark stored on hand ready for use under shelter.

Q. 17. How many places had they for drying tan, and how far were they from the furnaces?

A. In passing down the road I observed, at what they call the lower works, where they do currying, that they had some tan-bark there at a place, also for the purpose of drying; there were two places; one removed 100 yards, at the upper works; at the lower works it was immediately contiguous.

Q. 18. How often did the firemen feed this furnace at Sparrowbush?

(Same objection continued.)

A. From every five to ten minutes.

Q. 19. Did you learn why they brought eleven cords of wet tan and two of dry tan at the furnaces, as you have stated?

(Same objection continued.)

A. They run their works through the day and part of their works through the night up to 10 or 12 o'clock; this supply of tan-bark was to last them till they got through up to the morning.

Q. 20. Is there any particular mode of using dry fuel with wet, such as wet and dry tan, to produce the best combustion; and if so, what?

158 A. I have tried various kinds of fuel, varying in degrees of quantity of water, and have found in practice that when I could charge on to an incandescent bed of fuel the dry material, and then on that the charge of the wet material, that much better results could be obtained than by charging with the fuel having the average amount of water of both.

Q. 21. What sort of a draught had they to that furnace at Sparrowbush when you was there, and in what position were the ash-pit doors?

(Same objection continued.)

A. It was a perfectly clear day; the draught was strong; the ash pit was wide open.

Q. 22. In the Thompson furnace you have alluded to, when you had a good fire, what was the condition of the ash pits and mixing chambers of those furnaces as to heat?

A. In the lower chamber the charred material falling down through the grate made a hot carbonaceous fire, heating up the fire-brick grates to a high degree; in the upper chamber, where the wet fuel was deposited, and especially towards the mixing chamber, where the various products of combustion united and consumed each other, the temperature was at a white heat.

Q. 23. How was the ash pit at Sparrowbush as to heat, and what sort of grate bars did you find in those furnaces?

A. The ash pit was similar to any ordinary ash pit, and whatever material fell through the grates was lost, so far as any combustion was concerned; the grate bars were made of iron, with ¼ inch spaces, running lengthwise instead of crosswise, as in ordinary practice.

Q. 24. Did any appreciable amount of charred tan fall through those grate bars?

A. I did not take notice of the quantity, but from the closeness of the grates and the coarseness of the bark I could not consider that there was any great waste attending that part of the combustion.

Cross-examined:

Cross-q. 154. What was the weight of the two cords of wet tan-bark with which you say you evaporated in twelve hours 18,626 pounds of water at the Edgeworth tannery, at Malden, Massachusetts?

A. Nine thousand pounds, containing 62 per cent. of water, which would leave 38 per cent. of dry tan.

Cross-q. 179. Was the spent tan, or any of it which you saw consumed at Sparrowbush, dry or only partially dry, and what water did it contain, if you know?

A. The amount of water contained in what I have termed the wet tan at Sparrowbush was 60 per cent.; the amount of water in the dry tan was 15 per cent.

159 *Complainant's Exhibit A.*—R. E. S., Examiner, &c.

The people of the state of New York, by the grace of God free and independent, to Charles N. Black, of the city of New York, send greeting:

Whereas Moses Thompson, deceased, died intestate, and was, at the time of his death, an inhabitant of the city of Boston, state of Massachusetts, but died leaving assets in the county of Kings, by means whereof the ordering and granting administration of all singular the goods, chattels and credits whereof the intestate died possessed, and also the auditing, allowing and final discharging the account thereof doth appertain unto us, and we being desirous that the goods, chattels and credits of the said intestate may be well and faithfully administered, applied and disposed of, do grant unto you, the said Charles N. Black, full power by these presents to administer and faithfully dispose of all and singular the said goods, chattels and credits; to ask, demand, recover and receive the debts which unto the said intestate, whilst living at the time of his death, did belong; and to pay the debts which the same intestate did owe, as far as such goods, chattels and credits will thereto extend and the

law require; hereby requiring you to make, or cause to be made, a true and perfect inventory of all and singular the goods, chattels and credits of the said intestate, within a reasonable time, and return a duplicate thereof to our surrogate of the county of Kings within three months from the date of these presents; and if further personal property, or assets of any kind, not mentioned in any inventory that shall have been so made, shall come to your possession or knowledge, to make, or cause to be made, in like make manner, a
160 true and perfect inventory thereof, and return the same within two months after the discovery thereof; and also to render a just and true account of administration when thereunto required; and we do, by these presents, depute, constitute, and appoint you, the said Charles N. Black, administrator of all and singular the goods, chattels, and credits which were of the said Moses Thompson, deceased.

In testimony whereof, we have caused the seal of office of our said surrogate to be hereunto affixed.

Witness William D. Veeder, esquire, surrogate of our said county, at the city of Brooklyn, the fourth day of August, in the year of our Lord one thousand eight hundred and sixty-nine, and of our Independence the ninety-fourth.

[SEAL.] WM. D. VEEDER,
Surrogate.

Complainant's Exhibit B.—R. E. S., Exmr., &c.

The people of the state of New York to Eliza W. Fitzgerald, of the city of New York, the widow of William P. N. Fitzgerald, send greeting:

Whereas said William P. N. Fitzgerald lately departed this life intestate, being at or immediately previous to his death an inhabitant of the county of New York, by means whereof the ordering and granting administration of all and singular the goods, chattels, and credits whereof the said intestate died possessed, in the state of New York, and also the auditing, allowing, and finally discharging the account thereof, doth appertain unto us; and we being desirous that the goods, chattels, and credits of the said intestate may be well and faithfully administered, applied, and disposed of, do
161 grant unto you, the said Eliza W. Fitzgerald, full power, by these presents, to administer and faithfully dispose of all and singular the said goods, chattels, and credits; to ask, demand, recover, and receive the debts which, unto the said intestate, whilst living and at the time of his death, did belong; and to pay the debts which the said intestate did owe, as far as such goods, chattels, and credits will thereunto extend and the law require; hereby requiring you to make or cause to be made a true and perfect inventory of all and singular the goods, chattels, and credits of the said intestate within a reasonable time, and return a duplicate

thereof to our surrogate of the county of New York within three months from the date of these presents; and if further personal property, or assets of any kind, not mentioned in any inventory that shall have been so made, shall come to your possession or knowledge, to make or cause to be made in like manner a true and perfect inventory thereof, and return the same within two months after the discovery thereof, and also to render a just and true account of administration when thereunto required; and we do, by these presents, depute, constitute and appoint you, the said Eliza W. Fitzgerald, administratrix of all and singular the goods, chattels, and credits of the said William P. N. Fitzgerald, deceased.

In witness whereof, we have caused the seal of office of the surrogate of said county to be hereunto affixed. Witness, Gideon J. Tucker, surrogate of said county, at the city of New York, the 28th day of September, in the year of our Lord one thousand eight hundred and sixty-seven.

[SEAL.] GIDEON J. TUCKER,
Surrogate.

162 *Complainant's Exhibit C.*—R. E. S., Examiner, &c.

The United States Patent Office.

To all persons to whom these presents shall come, greeting:

This is to certify that the annexed is a true copy from the records of this office.

In testimony whereof, I, T. C. Theaker, Commissioner of Patents, have caused the seal of the Patent Office to be hereunto affixed, this tenth day of September, in the year of our Lord one thousand eight hundred and sixty-seven, and of the Independence of the United States the ninety-second.

[L. S.] T. C. THEAKER.

NEW YORK, *December 19th*, 1857.

Know all men by these presents, that I, Moses Thompson, of the city, county, and state of New York, in consideration of eight thousand dollars, to me in hand paid, to my full satisfaction, do hereby assign, transfer, and set over to William P. N. Fitzgerald the one undivided fifth part of all and singular the letters patent granted to me on the 31st day of March, 1857, for improvements in burning wet fuel, and a like undivided fifth part of letters patent granted to me on the 15th day of December, 1857, for improvements in furnaces for burning wet fuel, with one-fifth part of all the rights and privileges to which I am entitled by virtue of said inventions and said patents, for, to, and in the several states of New York, Pennsylvania, and New Jersey.

And I do hereby further sell, assign, and set over to said William a similar right to all such improvements as I may have made,
163 or shall hereafter make, during the life of said patents, or either of them, in the combustion of wet or moistened fuels.

To have and to hold the same, to him, the said William, his heirs, executors, administrators, or assigns, forever, for the sole use, benefit, and behoof of Gerald Fitzgerald and Josephine Fitzgerald, children of the said William; the said William having the whole control and management of all and singular the rights and interests to, hereinabove assigned, with full power to sell, license, or otherwise dispose of the said interests, or any part thereof, and to receive the consideration or considerations therefor, as trustee, for the sole use and benefit of the said Gerald and Josephine, share and share alike.

And it is further distinctly stipulated and understood, by and between the parties hereto, and for the considerations hereinbefore mentioned, that the said Thompson, his heirs, executors, administrators, and assigns, shall pay all the expenses of any proceedings, legal or otherwise, which may be necessary for establishing the validity of said patents, or either of them, or for establishing the fact of infringements of the same, where the same may be insisted upon by the parties hereto, but denied by the party infringing.

The foregoing assignment is not intended to convey any interest whatever in the tariff or license fee on any license in the said territory which the said Thompson has already granted, nor is it intended to extend to any territory except that of New York, New Jersey, and Pennsylvania.

MOSES THOMPSON.

In presence of—
J. M. MURRAY.
JOHN A. STEMLER.

Received and recorded March 10, 1858.

W. B. T.

164 Circuit Court U. S., southern district of New York.

CHARLES N. BLACK, administrator, etc., et al.,
vs.
SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, JR.

SAME
vs.
DANIEL STEVENS.

TUESDAY, *March* 8, 1870.

Present: ANDREW J. TODD, counsel for defendants; CHARLES N. BLACK, counsel for complainants.

JOSEPH B. HOYT, being called as a witness, and being duly sworn, deposes and says:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Joseph B. Hoyt; my age is 56; I reside at

Stamford, Conn.; I am engaged in the leather trade in New York, and in the tanning business.

Q. 2. Have you any knowledge of furnaces constructed to burn wet tan; if so, when first and how did you derive such knowledge?

(Objected to as leading.)

A. I have such knowledge; in 1853 constructed, or had constructed a furnace to obtain that result; it was in the town of Woodstock, Ulster county, New York.

165 Q. 3. How do you fix the time, and what part of the year was it?

A. I fix the time by a lease I took of the premises in which the furnace was constructed; the time of the year when the furnace was erected was May and June.

Q. 4. When did you take such lease, and how soon afterward did you commence preparations for the erection of this furnace?

A. I took the lease in November, 1852, and immediately after made contracts for the erection of an engine and boiler preparatory to putting them in operation in the spring.

Q. 5. When, then, would you say positively such furnace for burning wet tan was in actual operation?

A. In June, 1853.

Q. 6. Have you lately looked at your lease in order to verify the date?

A. I have.

(Lease produced for inspection of counsel for complainants.)

Q. 7. How long did this furnace continue in actual operation?

(Objected to on the ground that witness had not stated it ever continued in actual operation.)

A. Of my own knowledge five years, and from information from five to eight years after, and from aught I know it may be in operation now.

(Counsel for complainants objects to that part of the answer on information.)

Q. 8. How did it operate during the time you had personal knowledge of it?

A. It operated to effectually burn wet tan, and make an ample supply of steam for the purpose desired.

Q. 9. For what purpose was the steam generated in this furnace?

A. For driving a steam-engine of ten horse power.

Q. 10. Will you please describe the operation of burning wet tan in that furnace as practiced in June, 1853?

166 A. Our mode was first, in starting a fire with wood; after a sufficient heat had been obtained in the brick of the oven, the wet tan was shoveled on the grate bars; the feed door being closed, a rapid combustion was obtained.

Q. 11. Where were the grate bars?

A. The grate bars were under the arch of the oven in front of the boiler.

Q. 12. What was the position of the ash-pit door at the commencement of the operation?

A. It was open.

Q. 13. Was it changed during the operation?

A. Not unless we desired to stop the combustion.

Q. 14. When did you desire to stop the combustion?

A. When steam accumulated too rapidly.

Q. 15. What was then the position of the ash-pit door?

A. We closed it.

Q. 16. How many ovens were there to this furnace?

A. One.

Q. 17. What was the position, as respects its height, of the boiler to the arch of this oven?

A. The inner or underside of the arch was on a level with the underside of the boiler.

Q. 18. What was the width or distance apart from each other of the grate bars?

A. From one-quarter to three-eighths of an inch.

Q. 19. Did any charred or dry tan fall through these spaces; if so, to what extent?

A. There would some little fall through, but not enough to endanger the burning of the grate bars.

Q. 20. Do you run furnaces for burning wet tan now?

A. Yes, sir.

Q. 21. What is the distance apart of the grate bars in them?

(Objected to as immaterial.)

A. From three-sixteenths to a quarter of an inch.

167 Q. 22. How many ovens have you in such furnaces?

(Objected to as immaterial.)

A. One.

Q. 23. Was there any damper at the rear of the oven, or between the oven and the boiler, in the furnace you had in operation, June, 1853?

A. No, sir.

Q. 24. Was there any at or near the smoke stack or chimney?

A. I think there was, but I am not positive.

Q. 25. Was there anything burnt with the wet tan after the oven was properly heated, as you have testified, during the whole operation of burning the wet tan?

A. Not while the fire was steadily fed.

Q. 26. What was practiced in respect to the feeding in of the wet tan, so far as quantity was concerned?

A. We found it necessary to keep the gate bars well covered; say a layer of tan on them from six to ten inches thick.

Q. 27. What construction of boiler was in that June, 1853, furnace?

A. It was a flue boiler.

Q. 28. Can you produce or refer to a model that will fairly rep-

resent your said furnace so put in operation in June, 1853, as testified?

A. Yes; I have here a model.

(The model of said Woodstock furnace put in evidence, marked Defendants' Exhibit No. 5.)

168 Q. 38. Had you any knowledgn of any other furnaces for the burning of wet tan after this one of yours; if so, how soon after, and what was such furnace, and where situated?

(Objected to as immaterial.)

A. I had knowledge of a similar furnace being erected the same year in Newark, N. J.; it was in a patent leather manufactory.

169 Q. 39. Had you any knowledge of any other furnace about that time, or subsequent thereto; and, if subsequent, how soon after the June, 1853, furnace?

(Objected to as immaterial.)

A. I had knowledge of other furnaces being erected soon afterward through the year 1854.

Q. 41. How early in 1854 did you see the first of such furnaces as represented by Exhibit 6, which represents a Crockett furnace, and at what place?

A. I saw Mr. Crockett's as early as March, 1854, at the patent leather manufactory in Newark, N. J.

Q. 42. What did these furnaces like Exhibit 6 burn as fuel?

A. Wet tan.

Q. 43. How was the wet tan inserted in them?

A. It was thrown in by a shovel through the doors of the feed openings at the end and spread on the grate.

Q. 44. Was there any other mode of feeding these ovens?

A. At that time I had not seen any other.

Q. 45. When did you see any other mode, and explain how the wet tan was fed into the ovens in such other mode?

(Objected to as immaterial.)

A. The first that I remember to have seen was when we built our Corner tannery, as it was called, in Ulster county, N. Y.; it was fed at the openings on the top of the furnace.

Q. 46. Had the furnace which you saw in 1854, like Exhibit 6, openings in the top, as shown in Exhibit 6?

170 A. I do not recollect to have seen them.

Q. 47. Did you see the burning of the wet tan in this furnace which you saw in 1854 like Exhibit 6?

A. Yes, sir.

Q. 48. How were you enabled to see it?

A. On March 1st, 1854, the firm of Hoyt Brothers was formed, and from that time on they operated the factory of which this was a part.

Q. 49. By what means were you enabled to see the operation of the combustion of the wet tan in the oven of this furnace?

A. Upon the furnace doors were small slides by which small aper-

tures could be made, and through these the combustion could be observed.

Q. 50. What was the operation of this furnace as respects the combustion of the wet tan?

A. When the fresh fuel was thrown on one side of the furnace the intensity of the heat that was in the brick would be reflected upon the fuel, causing a rapid evaporation of its moisture and very soon igniting it in a flame.

Q. 51. After commencing to charge with wet fuel was any other fuel used during the operation?

A. None other.

Q. 52. What was the degree of heat generated by thus burning the wet fuel continuously, and for what purpose was it used?

(Objected to, as the witness has not stated wet fuel was burned.)

A. I can only state the degree of heat by saying that the fire-brick of which the arch was set would be from a red to a white heat; the steam made was used for driving an engine and for heating the ovens baking the enamel on leather.

Q. 53. What was the position of the ash-pit door at the commencement of and during the process of burning the wet tan?

A. It was open.

Q. 54. Was there any damper in the stack of this furnace?

A. There was.

Q. 55. What, if any, use was made of it?

A. The use made of it was to close it partially when steam was rising too high; in case it was desirable to arrest combustion altogether, we closed both the ash-pit doors and the damper in the stack.

171 Cross-q. 148. How often did you kindle the fire in that furnace at Woodstock?

A. They would ordinarily bank the fire at night by filling the arch full, or nearly so, and then shut off draft; it would remain hot during the night, so that very little fuel would set the fire going in the morning.

Cross-q. 149. What kind of fuel did you use for that?

A. Any little dry wood, or even a little dry tan, if we had it.

Cross-q. 150. Where did you take this wet tan from to put in the furnace?

A. It was taken from the leaches.

Cross-q. 151. How long a time after drawing off the water before you used it?

A. I supposed ordinarily they would draw off the water one day, let it stand over night, take the tan out of the leaches the following day, and then use it when they had occasion.

Cross-q. 152. Had it not been common to burn wet tan before you built this Woodstock furnace, to a limited extent, by spreading it on what was called cone grates?

(Objected to as immaterial, and notice that counsel is making the witness his own repeated.)

A. I do not think it was common; but efforts had been made to do it, with very indifferent success.

Cross q. 153. Look at this model, marked Complainants' Exhibit E, and state if you see any resemblance between it and your Woodstock furnace?

(Notice to cross 144 here repeated, and objected to as wholly immaterial, indefinite, and too general.)

A. In answer to that inquiry, I observe grate bars similar to those in the Woodstock furnace; an arch representing somewhat that arch; an ash pit similar to that, but not so deep; here are three ovens, in that there was but one; here is a chamber behind the ovens which was not in the Woodstock furnace; here is a damper arrangement between the furnaces and the boiler which was not there.

172 Q. 284. Were you at this time (November or December, 1852,) acquainted with furnaces used by tanners through the country, for the purpose of generating steam, so far as respects the kind of fuel they used; and did you so continue for several years?

A. So far as I was acquainted with tanners, who were using steam as a motive power, they were using wood for fuel, except those who had introduced the cone grates; they would partially dry the tan and burn some wood with the partially dry tan; I saw this operation at Mr. Sweze's tannery at Troy.

(That part of the answer in reference to the Troy furnace objected to by complainants' counsel; objected to as not responsive to the question.)

Q. 285. When did you first hear of Moses Thompson, or that such a person claimed to have an improvement for burning of wet fuels?

(Objected to as immaterial.)

A. I cannot state definitely just when, some years after the Woodstock furnace was built.

173 MONDAY, *March* 28, 1870.

Present—Counsel on both sides.

DAVID B. CROCKETT, called and sworn as a witness on the part of the defendants, deposes and says:

Question 1. What is your name, age, residence, and occupation?

Answer. David B. Crockett; age, 66; residence, Newark, N. J.; I am at present a manufacturer of paints and varnishes.

Q. 2. Have you any knowledge of furnaces constructed to burn wet tan; if so, when first and what is such knowledge?

A. Yes, sir, I have; I have built one myself in Newark at W. & O. Hoyt's, patent leather manufacturers, in 1853; I think about August, as near as my memory serves me; Exhibit No. 6 represents the furnace that I built; the oven was an arched fire-brick construction; the bridge-wall was fire-brick, and the wall protecting the boiler was fire-brick; the oven was entirely lined with fire-brick; it had a perforated grate; there were two feed-doors where the fuel was thrown in, and two ash-doors; it was made originally to feed at the top, but it was found on experiment that it was more convenient to feed at the doors.

Q. 3. When was this furnace referred to by you first operated?

A. About that time, in August; I am not positive as to the day of the month.

174 Q. 4. State how this furnace burnt wet tan; give in detail the way in which it was prepared for burning it, and how the wet tan was fed into the furnace.

(Objected to as immaterial.)

A. The fire was kindled with wood; when the furnace was got to a fair heat the tan was fed in with a shovel, wet; then the fire was kept up by alternately feeding; I don't know that I can give any further description, as the fire was kindled and burning.

Q. 5. How was the fire kept up from time to time?

(Same objection.)

A. By feeding at the doors alternately, as stated before.

Q. 6. What was fed at the doors alternately?

(Same objection.)

A. Wet tan.

Q. 7. Was there anything else fed in, while the furnace was in full operation, except wet tan?

(Objection continued.)

A. No, sir.

Q. 8. How long was the furnace kept in operation at a time by means of this alternate feeding in of the wet tan?

(Same objection.)

A. About a week; we would run it about a week till Saturday night, and then close it down, or bank it up as it might be called, to smother the fire.

Q. 9. What would you do on Monday morning with this furnace as respects the continuing of the combustion of wet tan?

(Same objection.)

A. Sometimes the night watchman would feed during Sunday and Sunday night, so that there would be sufficient fire on Monday morning to ignite the wet tan.

Q. 10. State if in this furnace the position of the ash-pit doors was changed during the operation of burning the wet tan; also state what was their position at the commencement of the operation.

(Same objection.)

A. The ash-pit doors were operated, opened and shut as air might be required for the combustion of the fuel.

175 Q. 11. How long or until when was the furnace so continued in operation, and if any change was made, when and for what reason, and state such change?

(Same objection.)

A. It might have been a month or it might have been six days before the furnace was stopped after it had been in operation, to make any experiments; I experimented with anthracite coal and a variety of fuel at different times to test the quality of the combustible fuel in burning it in a fire-brick arch.

Q. 12. What did you derive or learn from such tests?

A. My experiment showed that the gases from the anthracite coal could be burnt and produce a greater amount of heat in the furnace than in the fire grate under the boiler.

Q. 13. For what purpose was the heat generated by that furnace in August, 1853, used?

A. Used for operating a steam-engine for grinding bark; and steam was drawn from the boiler for leaching the bark.

Q. 14. How long did such furnace continue to be so used after August, 1853?

A. That furnace was used until the spring of 1854.

Q. 15. How did it operate in so burning wet tan within this period of time?

(Objected to as having been answered.)

A. With perfect success.

Q. 16. What was done in the spring of 1854 with reference to this furnace?

A. The furnace was changed from one end of the boiler to another on the opposite side.

Q. 17. State why this was done?

A. About that time we altered our drying ovens from a hot air to steam heat, requiring more steam than the boilers in use could make, placing a new boiler on the side occupied by the old furnace.

Q. 18. How was the receptacle for the consumption of fuel, attached to the new boiler, constructed?

A. The same as the model No. 6, with the exception of the
176 change in the doors from the front to the side, and dispensing with the feed-holes at the top, and dividing the ash-hole into two parts.

Q. 19. What fuel did you use in this new oven when it was constructed?

A. We commenced using wet tan.

Q. 20. What was used in the oven at the other side?

A. Wet tan.

Q. 21. Was there any change made in the kind of fuel used in either of these ovens; if so, when and why?

A. After building the two we found we had a scarcity of wet tan, and introduced at different times dust anthracite, and sometimes fine bituminous, mixed with the wet tan; this kind of fuel was introduced at times into both, but principally into the new furnace.

Q. 22. Was this dust anthracite or bituminous coal introduced into either or both of these ovens when you had plenty of wet tan?

(Same objection.)

A. No.

Q. 23. How long did these ovens continue in operation?

A. The first one about five years; the other one about the same time; but I am not positive of this.

Q. 24. How did they operate during all this time in the burning of wet tan alone for the purpose of producing steam?

(Same objection.)

A. There was no difficulty in producing what steam was required for daily consumption at the manufactory.

Q. 25. Did you ever introduce any more of these furnaces; if so, state where and when next after this one which you have already referred to?

(Same objection.)

A. I put up one for Mr. Webster, of Boston, August 15, 1854; I put up one for Mr. Sandford, a tanner, somewhere in New York State, August 14, 1854; A. Rumsey & Co., Buffalo, N. Y., September 22, 1854; and a casting for Hoyt Brothers' Shokan tan-
177 nery, Ulster co., N. Y., August 16, 1854; the same year, I think, there were two erected in Newark, one for the Chadwick patent leather factory, and one at T. P. Howell's patent leather factory. All these, excepting the two last, I have taken from my book here with me; I might have brought other books showing other furnaces put up; I put up a furnace for Burhause, Gray & Co., Warren county, I think; three in Philadelphia; I have not got the dates with me; they were put up, I think, in 1854 or 1855.

Q. 26. Did these furnaces, or any of them, substantially differ in their construction, principle, or mode of operation from the furnace you have described as first erected in August, 1853; if so, to what extent?

(Same objection.)

A. No, sir; no difference, except there were no feed-holes in the top; I will state Mr. Sandford's was a different furnace; it was built, I think, with three furnaces, and was taken down after a short operation, after having very unsuccessfully operated.

Q. 27. What was the cause of Mr. Sandford's furnace having operated very unsuccessfully?

(Same objection.)

A. There was a difficulty in getting the three separate furnaces or ovens hot enough to operate as well as the single furnace.

178 Q 33. Had you, prior to August, 1853, knowledge of furnaces containing ovens for the burning of wet fuels and substances; if so, how early, and where?

(Same objection.)

A. I think early in 1852 I saw an oven at Peddie & Morrison's trunk manufactory, Newark, N. J., for burning wet chips, leather, and the combustible waste of the factory generally.

Q. 34. Describe such oven and furnace?

(Same objection.)

A. It was an arch built of brick on the side of one end of the boiler, outside of the boiler, with the grate bars, fire or feed doors, ash pit open in the rear, directly exposing the boiler to view.

Q. 35. How did this furnace operate in the burning of such wet or refuse substances, and for what purpose was the heat generated thereby used?

(Same objection.)

A. When I saw it it operated very well; the heat was generated for making steam in a flue-boiler.

Q. 36. How early did you conceive of your plan of burning wet fuel, and how came you to conceive of it?

(Same objection.)

A. In the spring of the winter of 1852, or the spring of 1853, my attention being called to look at the furnace for burning chips, I thought it would be a good one for burning tan if properly constructed.

Cross-examined:

Cross-q. 112. Was not such a furnace as that model (Ex. No. 6) represents, an old idea in the year 1852?

(Same objection.)

A. I think it was older than that.

179 Cross-q. 142. How thick did you spread the wet tan on the grates?

(Objected to as immaterial.)

A. From six to twelve inches.

Cross-q. 143. Why did you adopt that thickness?

A. It was not confined to that thickness?

(By an error in numbering there is no cross-q. 144.)

Cross-q. 145. How thick did you usually spread it?

A. The average might have been ten inches; I am not positive about that; it was spread as it was required for consumption.

Cross-q. 172. Whereabouts in New York state—in what county—did you build the furnace for Mr. Sandford?

A. I cannot tell the exact county.

Cross-q. 173. What is Sandford's first name?

A. I do not know.

Cross-q. 174. Where did you put the feed-holes in that furnace?

A. There were three furnaces; they were fed from the door.

Cross-q. 175. How long since you built one of these furnaces, such as you have spoken of?

A. In 1857 or 1858; I am not positive as to date, but I can ascertain at home.

Cross-q. 176. Did you ever build one of these furnaces at a place called Candor, in this state?

A. I think there was one built at that place, but I will not be positive.

Cross-q. 177. How many furnaces did you build for Hoyt Brothers, and where?

A. I built four in all; one for W. & O. Hoyt at Newark, and two for Hoyt Brothers at Newark, and one for them at their tannery in New York state.

Cross-q. 178. How often did you clean out that furnace at Hoyt's under the boilers?

A. We were in the habit of cleaning out under the boilers once in

every two weeks, and the ash pits as often as the ashes accumulated to obstruct the draft.

Cross-q. 190. Did they not burn dry fuel in this furnace at Chadwick's with the wet tan?

A. I answered that question a few moments ago, sir.

Cross-q. 191. Did they not always more or less use dry fuel in that furnace?

180 A. They did; it was built for that purpose, for burning all their wet tan and combustible waste, chips, etc., about the factory.

Cross-q. 192. When they had no such combustible waste on hand, but a sufficient quantity of wet tan, will you undertake to swear that they did not use dry fuel with it to keep up combustion?

A. I would not undertake to swear to anything they did, as I was not present.

Cross-q. 193. Have you ever seen a Thompson furnace?

A. No, sir.

Cross-q. 194. Do you know anything of its economy in burning wet tan over dry fuel?

A. No, sir.

Cross-q. 195. In putting up these furnaces you have spoken of did you visit the several places yourself, or send some one to act in your behalf?

A. In three or four instances only did I go myself to attend to the construction.

Cross-q. 196. Name those instances.

A. One in particular was at a chemical works in Philadelphia; one other was in Troy, at Mr. Geary's, I think; there were others, but I have forgot their names and places.

Cross-q. 197. When did you build Geary's at Troy?

A. I don't remember the date; it must have been in 1854 or 1855; in 1854, I think.

Cross-q. 198. Did they burn wet tan at the chemical works?

A. No, sir; they burned the waste chips of dye-woods and nut-galls, and the waste generally accumulating from their extracts.

181 FRIDAY, *April* 8, 1870.

Present: Counsel for the respective parties.

MAURICE M. SCHULTZ, being called as a witness on the part of the defendants, and being duly sworn, deposes and says as follows:

Question 1. What is your name, age, residence, and occupation?

Answer. Maurice M. Schultz; age 43; I reside in Wilcox, Elk county, Pa.; I am a tanner.

Q. 2. How long have you been a tanner?

A. I worked at it about twenty-four years.

Q. 3. How long have you been conducting business as a tanner for yourself?

A. Twenty-three years.

Q. 4. At what different places was your tannery located?

A. Mamakating, Sullivan county; Glenwood, Susquehanna county, Pa.; Sparrowbush, Orange county, New York; Wilcox, Elk county, Pa.

Q. 5. When did you commence running your tannery at Sparrowbush, Orange county, New York?

A. I commenced running it in the fall of 1852.

Q. 6. Did you use tan as a fuel there at this time; if so, how and in what condition was the tan?

(Objected to as immaterial.)

A. We did use tan there at the commencement; burnt it on cone grates under the boiler. We could not burn it successfully wet, and we dried some of it partially.

182 Q. 20. You say you sent Mr. Isaac Sly to examine Mr. Hoyt's furnace as soon as said Hoyt notified you that he was burning tan successfully, and that he, Sly, spent some days there. What report did Mr. Sly bring back to you?

(Same objection, and as hearsay evidence.)

A. He reported to me that Mr. Hoyt had an oven working successfully, and he thought he could drive our power by putting in two.

Q. 21. How soon after his return was the furnace commenced to be constructed?

(Same objection.)

A. He commenced ordering materials immediately, and made draft of what was necessary.

Q. 22. You state that it was built in June or July, 1853. How soon after it was built was it commenced to be operated?

(Same objection.)

A. Immediately.

Q. 23. Of what material were the ovens in that furnace composed?

((Same objection.)

A. Fire-brick and fire-clay. The fire-brick were cemented with fire-clay.

Q. 24. What did such furnace burn as a fuel?

(Same objection.)

A. Wet tan-bark.

Q. 25. How, if at all, were the ovens prepared for the burning of such wet tan?

(Same objection.)

A. We heated them very hot with wood before we commenced putting the tan in.

Q. 26. At what point was the tan inserted?

(Same objection.)

A. We had two places for putting in tan in these ovens. We generally put it in at the front door. We had a hole through the top through which we occasionally fed it.

183 Q. 27. When you first ran the furnaces, at what point did you put it in, and how long did you continue before you changed?

(Same objection.)

A. We commenced feeding them from the top; the ovens were so high that it made it difficult to get the tan up there, and after feeding them from the top, possibly two weeks, we fed them after that from the lower door, except at nights at quitting time we would fill them from the tops so as to get them very full, so as to last all night.

Q. 28. How did you find that the ovens operated in feeding them at the doors, as compared with feeding them at the top?

(Same objection.)

A. I could not see there was any difference that amounted to anything. There was less labor in feeding them at the lower doors the way we were situated then—I mean the oven doors.

Adjourned to Saturday, April 9, 1870, at 11 a. m.

SATURDAY, *April* 9, 1870.

Present: Counsel for the respective parties.

Examination of MAURICE M. SCHULTZ resumed:

Q. 65. Did you ever hear or know of Mr. Thompson in connection with wet tan-burning furnaces?

(Same objection.)

A. Not till within two or three years.

Q. 66. Has any claim ever been made on you by any party claiming to represent a Mr. Thompson, or any one claiming under him, by reason of your using furnaces for burning wet tan?

(Same objection.)

A. There never has.

Q. 67. Are your furnaces at Wilcox, Pa., operated the same or differently from the June or July, 1853, furnace of which you have testified?

(Same objection.)

A. The same, with the exception that we feed from the top altogether.

184 Cross-q. 198. Who built those furnaces?

A. A man by the name of Job Van Kirk built a part, and a man by the name of Meagler built a part.

Cross-q. 199. Where do these men live?

A. Van Kirk lives in Wilcox, Elk county, Pa. I don't know Meagler's residence.

Cross-q. 200. Who employed Meagler?

A. Wilcox Tanning Company.

Cross-q. 201. Who worked there first in building those furnaces first—Meagler or Van Kirk?

A. Meagler.

Cross-q. 202. How many of the ovens did Meagler put in?

A. Eight.

185 Cross-q. 203. Van Kirk how many?

A. Two.

Cross-q. 204. Were you there when Meagler put in the eight?

A. I was.

Cross-q. 205. Who is the man who employed Meagler to come there, and what is Meagler's christian name?

A. John Ernhout employed Meagler to come there, and Meagler's christian name I never did know.

Cross-q. 206. Where is John Ernhout?

A. He lives in Wilcox, Elk county, Pa.; he is one of the partners of the Wilcox Tanning Company.

Cross-q. 207. Have you any knowledge whatever of Meagler's residence, or where he is to be found?

A. I have not. Some time ago a man told me that he lived in Binghamton; I made inquiries, and found it was not so.

Cross-q. 208. Is not that man's name and residence John A. Meagley, Binghamton, New York?

A. I positively do not know; I ought to know, but I do not know.

Cross-q. 209. How many feed holes are there in each oft he ovens of the Wilcox furnace?

A. Eight of the ovens have got two in each; my impression is now that two ovens have got three in each.

Cross-q. 210. What is the length and width of those ovens?

A. I think eight of them are eight feet long and four feet wide, and two of them, I think, are twelve feet long and four feet wide.

186 NATHANIEL A. BOUTON, being produced as a witness on the part and behalf of defendants, and duly sworn, in answer to questions proposed to him by A. J. Todd, esq., counsel for defendants, testified as follows:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Nathaniel A. Bouton; my age is 68 years; my residence Stamford, Connecticut; occupation, farmer; I learned the tanning and currying trade, and carried on the business about thirty years.

Q. 2. Were you ever at Woodstock, Ulster county, New York, and had charge of a tannery there; if so, between what periods of time, and whose tannery was it?

A. I went there in November, 1852, and was there five years, and from November till April, 1858—over that—in the employ of Messrs. Rees and Hoyt; the latter part of the time the firm was Hoyt & Brothers.

Q. 3. Was there a furnace erected in that tannery; if so, when was it commenced to be put into operation?

(Objected to as improper on rebuttal by complainants' counsel.)

A. There was one there; it was put there in June, 1853.

187 Q. 7. How was the wood used when you so commenced to run it?

A. It was used to start the fires.

Q. 8. After you had started the fire, when you so commenced to run that furnace in June, 1853, what was used as fuel?

A. Tan.

Q. 9. What was the condition of the tan?

A. It was pitched directly from the leach; it would drain some; we calculated to pitch it out ahead so as to have a quantity on hand.

Q. 10. What was its condition when it was thrown into the furnace after you had heated up the furnace with wood, as you have stated?

A. It was wet—as it was drained.

Q. 11. What were the grate bars composed of?

A. Cast iron.

Q. 12. How long did these grate bars last with this burning of wet tan alone, after the oven was once heated up by means of wood?

A. Some two or three weeks; cannot tell exactly; they lasted but a very short time.

Q. 13. State the cause of their burning out so quickly.

(Objected to as incompetent and immaterial.)

A. They were so far apart that they let the tan through and made a fire on both sides, and it was so hot that it destroyed them very soon.

188 Q. 22. What was the consequence of this not taking place with respect to the durability of such subsequent or second set of grate bars put into that furnace?

(Objected to as incompetent and as calling for an opinion.)

A. They lasted as long as I stayed there.

Q. 23. In the burning of wet tan alone, both in and during the time of the first and second set of grates, did you get steam sufficient for the purposes of the tannery, and about what pressure did it average?

(Objected to as immaterial and incompetent.)

A. To have the machinery run good, had to have fifty or sixty pounds of steam; that's what we try to keep, and sometimes when we wanted to heat liquors, we run the steam up higher by letting in the draft.

Q. 24. Did you keep, in the working of the tannery, on the average, a pressure of about sixty pounds of steam when burning wet tan alone, as you have stated?

(Objected to as leading and incompetent.)

A. We had no difficulty in keeping what steam we wanted, as a general thing; sometimes there would be a long wet spell and everything would get wet.

Q. 25. Question repeated.

(Objection repeated.)

A. We did.

189 Cross-q. 94. Was there any furnace at that tannery when you went there?

A. There was.

Cross-q. 95. Was that furnace in operation?

A. It was not.

Cross-q. 96. Was that furnace put in operation after you got there?

A. What shall I understand you—furnace for what?

Cross-q. 97. Can you answer the last question, if so, what?

A. There was a furnace for heating liquors.

Cross-q. 98. Did they use it for anything else?

A. No, sir.

Cross-q. 99. Was that furnaee there when you left that tannery?

A. It was not.

Cross-q. 100. When was it taken down?

A. It was taken down as soon as we got the other steam works in operation.

Cross-q. 101. When was that?

A. It was in June, '53.

Cross-q. 102. Will you swear that that furnace was taken down as late as January, 1854?

A. I won't.

Cross-q. 103. Will you swear that the other furnace was in operation as early as June, 1853?

A. No.

Cross-q. 104. Will you swear it was in operation as early as the fall of 1853?

A. I will.

NEW YORK, *December* 21*st*, 1871.

Present: Counsel as before.

Continuation of the testimony of NATHANIEL A. BOUTON:

Cross-q. 123 What was the difference between these two furnaces at that tannery at Woodstock?

(Objected to as incompetent; the witness ought to be called to state the facts., that is, to describe each furnace.)

A. The grates of the first were too far apart, and let the tan through too much.

Cross-q. 124. I mean what was the difference between the old furnace and new one?

A. The first one was of some rods from the tannery; it was a copper, placed in a vat, and the fire built inside of the copper; the water was then pumped into this vat and heated with the fire that was built in the copper. The second one was an oven at the end of the boiler; it was for driving a steam engine, and to heat the liquor by the steam.

Cross-q. 125. Was there any other difference between the two?

(Objected to as asking for a concluiion, instead of asking the witness for facts; that is, to describe the furnaces.)

A. The one burnt wood entirely at first; the other tan-bark mostly.

Cross-q. 126. I mean in construction; was there any other difference in the construction of these two furnaces than such as you may have stated?

(Same objection.)

A. The first one had no grates, merely a copper cylinder; the wood was burnt in that cylinder. The other had an oven at the end of the boiler, with grates.

190 Cross-q. 160. Then the reason these second grates were not destroyed is because you shoved the fire off of them at night; is that not so?

A. It is because there was not an intense heat on both

191 sides.

Cross-q. 161. Have you not just said that shoving the fire off the grates at night prevented their destruction?

A. I have said that the intense heat, night and day, on both sides, was what destroyed them.

Cross-q. 162. Question repeated.

A. That's what we done it for.

Cross-q. 163. Was the furnace injured in any other respects when the first grates were there?

A. Not that I know of.

Cross-q. 164. You were careful to spread this tan over the grates in such manner as to let the air shoot through all over its surface, were you not?

A. We were.

Cross-q. 165. And the flame came through holes made in the tan in this manner, did it not?

A. The flame made holes in the tan.

Cross-q. 166. Why did you use wood in wet weather?

A. It burnt better than wet tan.

Cross-q. 167. Because you got more heat than you could with the wet tan; is that the fact?

A. We could get it quicker with wood than we could with wet ton, until the oven got hot.

Cross-q. 168. The state of the weather decided somewhat then the amount of wood you used, did it not?

A. It did.

Cross-q. 169. Where did you get the wood from?

A. It was piled up generally, some of it in the engine-room; most of it was out doors.

Cross-q. 170. How many cords did you keep on hand?

A. I couldn't tell.

Cross-q. 171. Did you buy this wood?

A. I did.

Cross-q. 172. Who of?

A. Any one who came along who had it to sell.

Cross-q. 173. Was there any particular person you bought wood of?

A. No, sir.

192 Cross-q. 177. Did you buy wood all the time you were there?

A. The last year we bought none.

Cross-q. 178. Had enough on hand?

A. We had enough on hand—sold some to a man by the name of Vandervoort, who bought the tannery.

Cross-q. 179. How much did you sell to Vandervoort?

A. I don't recollect.

Cross-q. 180. About how much?

A. I couldn't form an idea.

Cross-q. 181. Can't you say whether it was as much as one hundred cords?

A. I think it was less than fifty.

Cross-q. 182. What kind of wood did you use in this furnace—cord wood?

A. It was cord wood.

Cross-q. 183. Thrown into the furnace on the tan, without cutting or splitting?

A. Four feet long; most of it split when it was hauled to us.

Cross-q. 184. Split, as it is prepared for market, do you mean?

A. I mean it was split; prepared for us expressly.

TUESDAY, *December* 26, 1871,
11 o'clock a. m.

Parties met pursuant to adjournment; same counsel present as before.

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Harvey S. Ladew; age, forty-five; residence, New York city; occupation, a tanner and leather dealer; a partner of the firm of J. B. Hoyt & Co., leather dealers, in New York city.

Q. 2. What is your earliest knowledge of furnaces constructed for the burning of wet tan?

(Objected to as incompetent and immaterial.)

A. The first furnace that I knew of was at Woodstock, Ulster co., New York.

Q. 3. Did you see that furnace in operation often, and what was it burning at such times when you saw it?

(Same objection.)

A. I think I saw it on an average once in three weeks the first year it was used; it was burning wet tan.

Q. 4. Was it burning wet tan alone, or was anything mixed with it?

(Same objection.)

A. It was burning wet tan alone.

Q. 5. How many ovens for burning wet tan had that Woodstock furnace?

A. Only one oven.

193 Q. 19. When was the furnace at the Corner tannery at Shandagan, Ulster county, New York, put up, and how many ovens had it?

(Same objection.)

A. It was built in 1861 or 1862, and had an oven on the side of the boiler next to the end, like the Exhibit Munson, twelve feet long and six feet wide.

Q. 20. How were the ovens of this boiler fed, and about how were the bridge walls arranged?

A. The ovens were fed from three feed holes in the top, in a row, in the centre of the arch; the boiler was bricked up at the end in front to the boiler, and a large wall back, the same as shown in Exhibit Morrison.

194 Q. 27. When did you get the Emmaville tannery at Fulton county, Pennsylvania, and what furnace was there, or constructed by you there, and how many ovens had it; the size, arrangement, and how fed, and with what?

(Same objection.)

A. We bought the tannery in March, 1867; built a furnace after that, that year; one oven twelve feet long, six feet wide, and four foot ash pit, three feet three inches fire chamber in height, built on the side of the end of the boiler, like Model Exhibit Morrison; there were three feed holes lengthwise of the oven, on the top; it was fed with wet tan.

Q. 28. How many hides were tanned annually and how many cords of bark were ground annually by this furnace, and what kind of bark was it?

A. I think we averaged 16,000 hides a year, and about 3,600 cords of bark a year; the furnace built in 1867 was laid over in 1868, I think, and made sixteen feet long and six feet wide, and four feet nine inches above the grate bars to under the arch; ash pit four feet deep, with four feed holes running lengthwise; I don't think there was any other change; there were no doors to the ash pits; three ash-pit openings on the side of the furnace; there was nothing put before them when burning wet tan.

Q. 29. Have you a tan-burning furnace at Flintstone tannery, Alleghany county, Maryland; if so, when was it put up? Describe its ovens, ash pit, &c.

(Same objection.)

195 A. We built a furnace there in August, 1867, sixteen feet long, ash pit four feet deep, five feet eight inches wide; ash pit door at end, three feet and a half wide, three feet three inches high; fire surface, six feet wide, sixteen feet long, three feet six inches high from top of grate bar to inside of top of arch; four feed holes on top, equally distant apart, running lengthwise; furnace on side of boilers; the arrangement of flues and bridge wall about the same as in Exhibit Morrison.

Q. 30. What did this furnace burn as a fuel, and were the ash-pit openings covered during the operation?

A. It burned wet tan, and we have no ash-pit doors; they are kept open.

Q. 31. Was wet tan used exclusively as a fuel?

(Objected to as leading and incompetent.)

A. Yes.

Q. 32. Was there anything else used as a fuel?

A. No, except for kindling fires.

Q. 33. Will you please state how much of the wet tan produced at that tannery this furnace consumed?

A. It varies in different times of the year. In the winter we use more steam and take more tan to make it. In summer, for five or six months, we use perhaps a little more than half; for the balance of the year three-quarters.

Q. 34. State what was done yearly at this tannery with this furnace with respect to the number of cords of bark ground and hides tanned?

A. In 1870 and 1871, an average of 20,000 hides and a trifle over 4,000 cords of bark; from 4,000 to 4,500 cords per year.

Q. 35. What else was done with the steam, if anything, in that tannery?

A. There was direct steam from the boiler for heating the handler house and beam house, a building 150 feet by 42; also to heat the limes and bates; also to heat a dry loft 125 feet by 42.

Q. 36. Was there any disadvantage resulting from there
196 being left so much tan unconsumed by this furnace at that tannery, and what would be the probable expense to you of its removal?

A. At Flint Stone a stream of water takes the tan away—we throw it in the water—there is very little expense about getting rid of it that way.

Q. 37. How do you do at the Emmaville tannery in this respect, if you have any tan left over?

A. We cart or scrape that away, and dump it in heaps.

Cross-q. 66. How long have you been in partnership with J. B. Hoyt?

A. I have been interested with him in business about twenty years.

197 A. I was interested with J. B. Hoyt since 1850; with Hoyt Brothers, I think, since 1854.

Cross-q. 82. What were you doing then, in 1853, at the Woodstock tannery?

A. I went there to measure the bark when the tannery was first leased by the Hoyts; also for nearly a year after it started, drew the drafts for money for the tannery.

Cross-q. 83. Who superintended the building of that furnace?

A. I think the direction was under J. B. Hoyt.

Cross-q. 84. Was J. B. Hoyt there?

A. He was there while they were building.

Cross-q. 85. Did Hoyt direct Chapman how to build it?

A. I think Chapman built it according to his directions; the masons and builders did.

Cross-q. 86. Do you mean to say you saw Hoyt, directing Chapman how to do this work?

A. I think I saw Mr. Hoyt give the plans and directions to the masons how to build the furnace.

Cross-q. 87. Do you know as a matter of fact and are you willing to swear you saw and heard Hoyt give such directions to Chapman?

A. Before the furnace was built Mr. Hoyt explained to me the plan of building the furnace, and I saw him giving directions as to the details of the plan of building the furnace to the masons.

Cross-q. 88. What, if any, are the peculiarities of this furnace differing from an old-fashioned oven?

(Objected to as immaterial.)

A. A furnace of this kind has iron grate bars and an ash pit; grate bars let up the air into the burning space or oven; the oven is lined with fire-brick; the doors are closed in front of the burning space, except when the fuel is put in; these are a few points of difference; I don't profess to be thoroughly posted as to an old-fashioned oven.

Cross-q. 89. Is there any other difference?

198 A. I think there is a fire discharge at the rear of the oven, connected with a chimney or stack.

Cross-q. 90. Any other difference?

A. I don't understand an old-fashioned bake oven.

Cross-q. 91. Can you state anything else which you regard as a difference?

A. Without knowing definitely what you mean by a bake oven, I cannot make a comparison.

Cross-q. 92. I refer to an old-fashioned oven; an instrument well known as such; can you state any other difference?

(Objected to as vague and irrelevant and as assuming.)

A. Without knowing definitely what you mean by an old-fashioned oven, I cannot compare the furnace with something that I don't know about.

Cross-q. 93. Did you ever see or hear of an oven before this at Woodstock, with grate bars and an ash pit, or lined with fire-brick?

A. I was with Mr. Hoyt, in Newark; I think in the spring or fall before the oven was built at Woodstock, and a gentleman took us to a place in Newark, and showed us an oven which, I think, had an ash pit and fire-brick arch.

Cross-q. 94. Is that the first time you ever saw or heard of an oven with an ash pit, grate bars, and a fire-brick arch, or either of them?

A. I saw grate bars and ash pit before, but I think not a fire-brick arch in an oven, that I remember.

Cross-q. 95. Do you mean attached to an oven?

A. No, never before that, attached to an oven.

Cross-q. 96. Had you ever seen an oven of any sort before?

(Objected to as immaterial.)

A. Yes.

Cross-q. 97. How was it built?

A. I have seen one built of tin called an oven—bake oven.

Cross-q. 98. Did you ever see one built of brick?

199 A. I might have; think I have.

Cross-q. 99. How did the Woodstock one differ from that, if at all?

(Objected to as vague, indefinite and too general.)

A. I think if I saw a brick oven it had not iron grate bars, and I don't know that a brick oven has an ash pit directly under the burning surface; think there are other points of difference which were, in part, explained by my former answer.

Cross-q. 100. Did you ever build an oven?

A. I have given directions for building ovens for burning tan.

Cross-q. 101. What is the difference, if any, between this Woodstock furnace or oven and the other furnaces or ovens you have referred to in your direct testimony, excepting the two at Boiceville and at Samsonville?

(Objected to, as the witness has stated the facts respecting the construction of said furnaces and as asking for an opinion.)

A. Difference in size of furnaces and ash pits, and in some of them difference in place for feeding.

Cross-q. 102. Any other difference?

A. I think in the whole they are essentially alike, except as to what I have stated, and in width or space between the grate bars.

Cross-q. 103. Which of them differed from the Woodstock furnace in that respect, the grate bar space?

A. I don't know that I know the space between the grate bars at Woodstock.

Cross-q. 104. Were you at Woodstock when this furnace there was first put in operation?

A. I may have not been there the day they started it, but I think I was surely there within a week of the time it was started.

Cross-q. 105. Did you ever feed it yourself?

A. I don't know that I have shoveled tan into it.

Cross-q. 106. Did you ever throw wood in it?

A. No.

200 Cross-q. 107. Are you certain of that?

A. Yes.

Cross-q. 108. Did you ever see it in operation afterwards to notice it?

A. Yes.

Cross-q. 109. Did you notice how the tan burned in it?

A. Yes.

Cross-q. 110. Were they not careful to spread the tan over the

grates in this furnace in such manner as to let the air shoot through over its surface in spots?

A. My recollection is that they kept it covered about six inches with tan all over. perhaps more than six inches.

Cross-q. 111. Didn't the flame come through holes made in the tan, in the manner indicated by the last question?

A. I think if the tan was burned off from the grate bars in spots, it would come through those holes and show a flame.

Cross-q. 112. Didn't the flame usually come through holes made in the tan, as indicated by the two last questions?

A. When the furnace was properly fed, it did not.

Cross-q. 113. How did the flame operate when the furnace was properly fed?

A. It would show itself evenly over the whole surface of the oven.

Cross-q. 114. How did it get on to the surface if not by making holes through the tan?

A. I think it was made on the surface by the concentration of heat in the fire-brick overhead, reflected back on the tan.

Cross-q. 115. Then you state, as the result of your observations at this furnace, that the flame was created by the heat reflecting from the brick arch of the furnace or oven, down on the wet tan thrown in it for fuel; is that so?

A. I think the great heat from the brick first dries the tan,
201 or takes up the moisture from the tan, and helps to burn the tan.

Cross-q. 116. Can you answer the last question categorically—yes or no?

(Objected to as already answered and as incompetent.)

A. I don't understand the question in a way that I can answer it yes or no.

Cross-q. 117. What is there about the question obscure to your mind?

A. That, in part, is, there may be other causes of combustion that I do not understand.

Cross-q. 118. Question 117 repeated.

(Objected to as fully answered.)

A. I think I answered the question.

Cross-q. 119. Is there anything obscure to your mind in the question referred to?

(Objected to, as the matter has been fully answered and as immaterial.)

A. If I understand the question, you ask me whether the heat from the fire-brick over the arch burns the tan; I think I have answered the question as clear as I can.

Cross-q. 120. Do you profess the have experience in reference to furnaces of this description at Woodstock?

A. I think I know how to build them and to work them successfully; but I don't claim to understand them scientifically; there are

things about combustion that I do not understand, and do not claim to understand.

Cross-q. 121. Did you ever feed one like this at Woodstock; if so, when, where, and how long?

A. To shovel in tan? I don't know that I ever fed one half a day; don't know that I ever have an hour.

Cross-q. 122. Did you ever feed one at all; if so, when and where, and how long?

A. Yes; at the Corner tannery, Shokan tannery, Flintstone
202 tannery, Emmaville tannery, and I think at others, not regularly for a day at a time anywhere.

Cross-q. 123. What is the difference, if any, in the manner of feeding the Woodstock furnace from that pursued at the other places you have mentioned, except feeding at the top instead of the front door, and excepting from your answer the furnaces at Boiceville and Samsonville?

(Objected to as incompetent, as the witness has already stated the facts connected with the feeding these respective furnaces.)

A. The size of the furnace above the grate bars and under the arch is greater in all the furnaces, except the one at Shokan, which was run from 1857; the one at Shokan was fed from the front door, and filled the same as the one at Woodstock; the difference at the other furnaces is that when we fill them we generally fill them full up to the arch under the whole.

Cross q. 124. Are you willing to swear that you so operated the furnace you have referred to at Candor—that is, filled it full?

A. I don't claim to know personally about the feeding of that furnace, and my answer was intended to refer to the Flintstone, Emmaville, and Corner tannery and Shokan that I spoke of.

Cross-q. 125. Are you willing to state under oath that both coal and wood were not used with the wet tan in that furnace when in operation at Candor, while in possession of Hoyt or his firm?

(Objected to as too general and indefinite.)

A. I don't know whether wood or coal was used or not.

Cross-q. 126. Is that tannery owned by your firm now?

A. No.

Cross-q. 127. Has not that furnace been recently torn down and a Thompson furnace put there in its stead?

A. Not that I know of.

203 Cross-q. 128. Have you any other tanneries besides those you have enumerated? If so, name them.

A. We own now five tanneries—Flintstone, Emmaville, Rays Hill, Paw Paw, and Wills' Creek tanneries.

Cross-q. 129. Where is the Wills' Creek tannery?

A. At Cumberland, Maryland.

Cross-q. 130. Have you a furnace there?

A. Yes.

Cross-q. 131. How many ovens?

A. One.

Cross-q. 132. Who built it?

A. James W. Jones & Son were the owners; it was built before we bought it; we have remodeled it since a little.

Cross-q. 133. Did you ever own the Monroeville tannery, Sullivan county, New York?

A. I was part owner with Hoyt Brothers.

Cross-q. 134. When did you buy that?

A. I think I became an owner in that in 1868; either 1867 or 1868, not sure which.

Cross-q. 135. When did Hoyt Brothers get it?

A. I don't know the year.

Cross-q. 136. About how many years before 1868?

A. I don't know when they bought it.

Cross-q. 137. Were you ever there?

A. Yes.

Cross-q. 138. When first?

A. I think in the winter of 1867 and 1868.

Cross-q. 139. When did you sell it?

A. The firm of Hoyt Brothers was dissolved in 1870, and the new firm of Hoyt Brothers took the Monroeville tannery.

Cross-q. 140. Had you a Thompson furnace there?

A. I don't know as I know what a Thompson furnace is, and I never examined the one that was there.

Cross-q. 141. How many times have you been there?

A. I think about three times, may be four.

Cross-q. 142. What kind of fuel did they burn in that furnace?

204 A. I think they burn wet tan.

Cross-q. 143. How many ovens has it?

A. I don't know.

Cross-q. 144. What kind of grate bars?

A. I don't know.

Cross-q. 145. How did they feed the wet tan into this furnace?

A. I think from the top.

Cross-q. 146. Did you ever feed it?

A. No.

Cross-q. 147. Did you ever own a tannery at Manchester, Wayne county, Pennsylvania?

A. The firm of Hoyt Brothers owned a tannery there, and I was a member of the firm.

Cross-q. 148. Were you ever there?

A. Yes.

Cross-q. 149. How many times?

A. I can't say; I think about three times; might possibly be five; not less than three nor over six.

Cross-q. 150. Did you have a Thompson furnace there?

A. I did not examine the furnace.

Cross-q. 151. What kind of fuel did you use at that furnace?

A. I suppose wet tan; whether anything with it or not I don't know.

Cross-q. 152. How is the wet tan fed in it?

A. I think from the top, but I don't know.

Cross-q. 153. What kind of grate bars had that furnace?

A. I don't know.

Cross-q. 154. Did you ever hear either of these furnaces at Monroeville or Manchester spoken of as a Thompson furnace?

(Objected to as irrelevant and calling for hearsay.)

205 A. I have seen it in the testimony of Mr. Hoyt, in which he states that it was a Thompson furnace, or that he supposed it was.

Cross-q. 155. Is that the only time you ever so heard?

(Same objection.)

A. I don't remember to have heard it, but I might have.

Cross-q. 156. Which of the furnaces you have mentioned had a flue leading from the oven to the boiler, such as exhibited by the Exhibit Morrison?

(Objected to as already answered in the direct.)

A. I think most of them are essentially like that.

Cross-q. 157. Had the Woodstock furnace such a flue, or do you see such a flue represented in Defendant's Exhibit 5?

A. I think there is some little difference in the two models I see before me.

Cross-q. 158. Do you mean to swear that the flues leading from the oven to the boiler of these furnaces you have mentioned most resemble the flues as shown by Exhibit No. 5 or by Exhibit Morrison?

(Objected to as already answered in the direct.)

A. The furnaces that are on the side of the end of boilers have a close resemblance to the Morrison. The furnace that was built at Shokan was very near like Exhibit 5, except back of the grate bars it more resembled the Morrison; that is my recollection of it.

Cross-q. 159. Which ones, if any, were like Exhibit 5 with respect to this flue?

A. I think they are all essentially like that; the difference, if any, is in the support for the boiler—an arch in front of it.

Cross-q. 160. Had you in view to build a diving flue to any of these furnaces leading from the oven to the boiler, when they were built?

(Objected to as wholly immaterial whether a diving or ascending flue, having reference to Thompson's claims.)

206 A. The first oven, built at Shokan, in 1857, I think, was built under the direction of J. B. Hoyt; and my recollection is, that at the rear of the grate bars a wall of fire-brick was laid up; back of it a fire-brick arch, that supported the boiler in part, and dropped below this wall and left a space like that in Exhibit Morrison; the furnaces at the other tanneries, I think, are nearly like Model Exhibit Morrison.

Cross-q. 161. You have just said that they are like the Model Exhibit 5 in this particular; now you say they are like Morrison in this particular; which do you mean?

(Objected to as a misrepresentation of the witness' testimony.)

A. I mean that they are essentially like Model Exhibit 5, except the wall at the rear of the grate bars, and the arch back of that wall, in front of the boiler, and there may be some other little difference that I don't think of.

Cross-q. 162. To which of these several furnaces does this last answer apply; name them?

A. I think it applies to Shokan, where the furnace was in front of the boiler; it may apply to a furnace built at Grayville, Herkimer county, N. Y., and it may apply to the Flintstone, Emmaville, Paw Paw, and Ray's Hill tannery, with the difference of the furnace being placed on the side of the end of the boilers at the last-named tanneries, and some other things which I may not think of.

Cross-q. 163. Is that as certain as you can make your answer to your last question?

A. I gave the answer as my recollections are at this time.

Cross-q. 164. If there are any such flues in either of those furnaces as you have named, why were they so constructed?

A. The first furnaces were built by Mr. Hoyt; the others have been pretty much copied after them; and I do not claim to be competent to explain the particular reasons of all the particular points about them.

207 Cross-q. 165. You mean to say that those furnaces you have referred to as having been built by you, were copied after the Woodstock furnace?

A. I mean to say they are not exact copies of the Woodstock furnace, as I understand it, in every particular.

Cross-q. 166. How many feed-holes were there in the furnaces at Monroeville and Manchester?

A. I don't know.

Cross-q. 167. One or more?

A. I don't know.

Adjourned to ten o'clock a. m. of December 28, 1871.

NEW YORK, *December* 28, 1871.

Present—Counsel for respective parties.

Cross-q. 168. Did your firm ever own the tanneries at Boiceville and Samsonville you have referred to?

A. No.

Cross-q. 169. Who owns them, and where are they situated?

(Objected to as immaterial.)

A. Both of them are in the town of Olive, Ulster county; Henry A. Samson was formerly the owner of the Samsonville tannery and part owner of the Boiceville; Lemuel Boice owned the balance of the Boiceville.

Cross-q. 170. Were the furnances at the Monroeville and Manchester tanneries like those you said at Boiceville and Samsonville?

A. I don't know.

Cross-q. 171. Has your firm owned any other tanneries except those you have mentioned, since you have been a member of it, or since the year 1853?

A. I don't think of any other than what was mentioned yesterday.

Cross-q. 172. Have you doors on the side of the ovens of those furnaces you alluded to in your direct testimony?

208 A. Above the grate bars we have.

Cross-q. 173. How many, say, in the Flintstone furnace and the furnace at Emmaville?

A. Four in each, above the grate bars.

Cross-q. 174. What kind of an instrument do you use, if any, to put in the ovens from these doors for any purpose?

A. I think we use an iron scraper to clean off the ashes sometimes from the grate bars.

Cross-q. 175. Has this iron scraper a long handle?

A. It's an iron rod, probably seven feet long, with the end turned.

Cross-q. 176. Couldn't the fireman spread the wet tan in the furnace over the grate bars with this scraper if he saw fit?

A. If the furnace was full of tan he would find it difficult to work the rod through it; if the furnace was nearly empty he could push the tan over the grate bars.

Cross-q. 177. How large are these doors?

A. I think they are twenty inches long and about ten inches high.

Cross-q. 178. Have they any holes in them?

A. At some of the tanneries they have a hole, covered with a slide, in the center of the door.

Cross-q. 179. Why would the fireman find it difficult to spread the wet tan over the grate bars in the first case suggested by you?

A. There would be a solid body of tan, from three feet three to four feet and a half, in front of the door, and the grate bars would be covered when the furnace was full.

Cross-q. 180. Are there slides in the doors on the sides of the oven of the furnace at the Flintstone tannery?

A. Yes.

Cross-q. 181. How many visits have you paid to that tannery in the last year?

A. I think a hundred.

Cross-q. 182. For what special purpose?

209 A. To conduct the operations of the tannery.

Cross-q. 183. In which of the ash pits of these furnaces have you known persons to go in when in operation?

A. Ray's Hill tannery, Flintstone tannery, Wills Creek tannery, Paw Paw Tannery.

Cross-q. 184. Give the names of those present.

A. I think I have seen Oliver Lockwood in at Ray's Hill,

Wenrick at Flintstone, A. D. Ladew at Wills Creek, David Woodworth at Paw Paw, and I have been in each of them myself.

Cross-q. 185. Have you seen any one else in them?

A. I think I saw Jackson Schultz in them at Ray's Hill; I went there with him.

Cross-q. 186. Ever see Hoyt in?

A. I think I saw him in at Wills Creek tannery.

Cross-q. 187. Why did you go in these ash pits?

A. For different reasons—one might have been to see whether the grate bars were right; to see the burning of the tan; to see how it looked from under the furnace; another, merely out of curiosity to see, to know that I could do it.

Cross-q. 188. When did you and Schultz go in this ash pit?

A. I think something over a year ago, when we were at the tannery.

Cross-q. 189. Hadn't you then a notion of being a witness in this case?

A. No.

Cross q. 190. How long back is it since you first appeared here as a witness in this case?

A. I think it was the day before yesterday.

Cross-q. 191. Are you willing to swear that you was not in this building, called here for this case, while testimony was being taken in it, months ago?

A. I think I was in this building while this case was on, but I am willing to swear that I did not then know or expect that I would be a witness in this case.

210 Cross-q. 192. When you was in the ash pit did you take a light with you?

A. No.

Cross-q. 193. When you and Schultz went in the ash pit, at the time you have stated, was there a good fire overhead in the oven?

A. I think there was.

Cross-q. 194. State how that was.

A. I know the tannery, machinery, and engine was in full operation at the time; also opened the side door of the furnace, which showed the fire.

Cross-q. 195. How many feet of tan was there overhead?

A. In the centre there may have been four feet; at the side, perhaps, not one foot.

Cross-q. 196. Was there one foot over the whole grate surface?

A. I think there was an average of more than that.

Cross-q. 197. All of it wet when put in the furnace?

A. I think so.

ALLEN DEVEREUX, being duly sworn as a witness on the part of the defendants, in answer to interrogatories proposed to him by A. J. Todd, esq., defendant's counsel, testifies as follows:

Question 1. What is your name, age, residence, and occupation?

Answer. My name is Alvin Devereux; age, fifty-one years; residence, Deposit, Broome county, N. Y.; occupation, manufacturer of leather.

Q. 2. Were you acquainted with Mr. Thompson; if so, when and under what circumstances did you first become acquainted with him?

A. In the year 1854 I first knew Mr. Thompson; my attention was called to some tan-burning ovens he had been putting in for Mr. Weed at Binghamton; I went there to look at the ovens, and met Mr. Thompson there for the first time.

211 Cross-q. 89. Did you ever see wet tan burned to any extent in any sort of furnace, before you saw the furnance at Weed's tannery at Binghamton, in 1854?

A. I saw tan burned under the boilers in several different tanneries before that time and since that time.

Cross-q. 90. Was it not burned in that way with indifferent success?

A. I saw it burned with perfect success in a tannery of our own as long as we run it; it burned down.

Cross-q. 91. Do you pretend there was any such general practice of burning wet tan under boilers without the aid of dry fuel, either then or now?

A. I don't pretend that the practice was general, but that it was done in certain localities I do pretend.

212 Cross-q. 92. Had not different devices been made with the attempt to burn wet tan, such as cone grates, and failed?

A. In many instances they did fail; I failed signally myself in one instance.

Cross-q. 93. Was not the furnace which Thompson built at your tannery the second one he built in that county, and did you not know that his invention was then of recent origin?

A. I always understood that was the second furnace, but I did not know when he commenced at our place that the thing was just invented.

Cross-q. 94. What took you to Weed's tannery when Thompson was there?

A. Mr. Weed came to our tannery and told me about the furnace, and said I had better come over and see it; that was the occasion of my going.

Cross-q. 95. Then you did not employ Thompson to build for you until after you had inspected the furnace at Weed's?

A. No, sir.

Cross-q. 96. To what extent was this furnace which Thompson built for you destroyed?

A. The brick work had pretty much burned out, the arches had fallen in partly, and the feed holes, as Thompson constructed them, burned out; the grates, as I before stated, were twisted, warped, burned, and I don't know but melted together. In some places the ash-pit wall had given way; that is all I think of now.

213 GEORGE V. SORNBURGER, being duly sworn as a witness for the defendants, in answer to interrogatories propounded to him by A. J. Todd, esq., counsel for defendants, testified as follows:

Q. 1. What is your name, age, residence, and occupation?

A. My name is George V. Sornburger; age 42 years; Cannonsville, Delaware co., N. Y.; occupation, tanner.

Q. 2. Were you acquainted with Moses Thompson; if so when and under what circumstances did you become so acquainted with him?

A. He came to Mr. Devereux's tannery in the fall of 1854, and put in a set of ovens, and I got acquainted with him then.

Cross-q. 122. When did you go to work for Tanner and Devereux?

A. I commenced on the twelfth of May, 1855.

Cross-q. 123. How long did you work for them?

A. Most two years.

Cross-q. 124. Who did you work for after that?

A. Well I worked a short time; I worked for Frazer and Hoagland, Strong and Robertson, and several others, I couldn't remember all now.

Cross-q. 125. Name those you can remember?

A. How and Lincoln, Wales and Gildersleeve, Samson and Pratt; that's all I remember now.

Cross-q. 126. Can't you name any others?

A. That is all I guess; all I think of. I'll add Kiersted and Swan.

Cross-q. 127. What business did these parties do?

A. Tanners.

Cross-q. 128. Can you name any others you worked for since you left Tanner and Devereux?

A. I think that's all.

Cross-q. 129. When did you go into business with Kenyon & Co.?

A. I think it was in the year 1865.

Cross-q. 130. How long did you work for Frazer and Hoagland?

A. I couldn't say. From two to four weeks, as near as I can get it.

Cross-q. 131. When was it?

A. 1857.

Cross-q. 132. Whereabouts?

A. It was in May, 1857, at their tannery at Calicoon—I think they called it Thurmanville.

Cross-q. 133. Now owned by Hoyt Brothers, is it not?

A. I don't know, sir.

Cross-q. 134. What did you work at for them?

A. I helped to repair their engine and superintend the burning of tan.

Cross-q. 135. What did they pay you for that job?

A. I don't remember; I think about three dollars a day.

Cross-q. 136. Who was the mason that was building the furnace?

A. I think that one was named Meagley and I think another

named Smith. Mr. Simpson brought them there from Binghamton.

Cross-q. 137. Do you refer to Daniel B. Simpson and John A Meagley of Binghamton?

A. I do, sir.

214 NEW YORK, *January 4th*, 1872.

Present—Counsel as before.

CHARLES COOPER, being duly sworn as a witness on behalf of defendants, deposes and says as follows:

Question 1. What is your name, age, residence, and occupation?

Answer. Charles Cooper; I am 57 years old; I reside at Sparrowbush, Orange county, New York; by occupation, tanner; I am a member of the firm of Cooper, Swazey & Co.

Q. 2. How long have you been in possession of the tannery at Sparrowbush, N. Y.?

A. Five years.

Q. 3. How many furnaces were there when you first took possession, and how many ovens in each furnace, and where were they situated?

A. There were two furnaces—one furnace at the tannery proper, with two ovens, and one at the currying shop, with one oven.

Q. 4. Were the ovens of these furnaces lined with fire-brick, and state what kind of grates they had, and the width apart of the grate bars?

215 (Objected to as immaterial and irrelevant on rebuttal.)

A. The furnaces were lined with fire-brick throughout; the grates were iron; the bars were three-eighths of an inch apart, except by a little variation of warping; the height of the ash pits under the grates was about two feet.

Q. 5. What did you burn as a fuel in these two furnaces after you took possession of the tannery, five years ago; after the furnaces were properly heated up?

(Same objection.)

A. For the first two years—speaking of the furnace with the two ovens—we burned wet tan from the leaches, with wood additional; at the oven at the currying shop at that time we burned hard coal in; it had a low stack; the latter part of the time that building was standing we burned a little wet tan on the coal; that furnace was destroyed when the building burned in 1868; we then rebuilt the shop and built a new furnace; we used in that as a fuel for about a year and one-half wet tan, with the exception as to starting fires in the morning.

Q. 6. Referring to the oven of the furnace in which you burnt wet tan exclusively for about a year and a half, how did you keep its ash pit, and also state what the bars were composed of, and how far apart were such grate bars; give a general description?

(Same objection.)

A. We kept the ash pit as free from ashes as possible and kept the door open, except as to time when we shut down to go to dinner, and at nights; we shut the doors then; the grates were of iron, leaving openings between of three-eighths of an inch.

Q. 7. Why did you stop burning wet tan exclusively in that furnace?

(Same objection.)

A. About that time, I am not positive as to dates, we changed grates, and took out the grate we had been using and laid it
216 aside; we put in the Tupper grate, or angle-bar grate; in this grate the bars were three-eighths iron, with a quarter of an inch opening—they worked tolerably well for a while, but they filled up partially, and we were obliged to substitute some dry fuel in consequence of that; we used those grates in that way until the latter part of last summer or early in the fall; we then added some new machinery, requiring more power; we were obliged to take out the Tupper grate and put in the old grate, which we did; and in consequence of the additional power required and the failure in the furnace, which cracked, we found it necessary to continue using some dry fuel.

Q. 8. How does this oven, and its outlet to the space under the boilers, compare with the ovens and their outlets to the boilers of the other furnace?

(Same objection.)

A. The construction is intended to be the same; we vary these things according to the size of the stack; the flues are what regulate those things; the flues in this furnace and boiler are proportionally smaller than the other.

Q. 9. To what extent was draft necessary and essential to both of these furnaces, having reference to the single-oven furnace when it was burning wet tan alone?

(Same objection.)

A. The draft when the furnace was built at the currying shop for burning wet tan was perfectly ample; both wanted a good, lively, free draft.

Q. 10. Why did you burn dry fuel along with your wet tan, in your double-oven furnace?

(Same objection.)

A. For the reason that we could not make steam enough to do the quantity of worked required without.

Q. 11. Will you please state what work you do annually with that double-oven furnace?

(Same objection.)

A. We tanned 59,621 hides last year; they were dry flint hides, with the exception, perhaps, of 500 or 600 green hides or
217 thereabouts; we ground about 4,800 cords of bark, between 15 and 16 cords per day, and also received about 200 cords ground bark from our mill at Basket Station; in 1870 we tanned 51,000 dry flint hides, and about 1,000 green hides in addition; we

ground about 4,494 cords of bark and received 248 cords ground bark from our mill at Basket Station.

Q. 12. Will you please state briefly what machinery, etc., you drove at this tannery during such years?

(Same objection.)

A. First, one six section improved Beecher bark mill; two large milling wheels, one is eight feet in diameter and one nine, four feet wide each; one No. 3, centrifugal pump, forcing a column of water three inches in diameter, twenty-eight feet high, about two hundred gallons per minute; four engines, paddle wheels; a common lift pump, five-inch calibre; four splitting machines for splitting leather; one machine for grinding splitting knives; one large grind-stone; one cutting wheel, eleven feet diameter; direct steam from boiler, constantly through one-inch calibre pipe; one large double-acting hide mill; one water pump that we use during the summer for about three months for supplying the tannery with water from the canal; two and one-half inch bore, eight-inch stroke, one hundred and fifty strokes per minute.

Q. 13. How much dry fuel did you use annually during these two years, in addition to the wet tan burned in order to do this amount of work stated by you?

(Same objection.)

A. I should think it was the value of one hundred cords of good, dry hard wood, annually.

Q. 14. Did it exceed that?

(Same objection.)

A. I should think not.

Q. State whether you burn in that furnace all the tan-bark ground at that tannery.

218 (Same objection.)

A. We do not; we burn all the tan that we make in the three furnaces, and draw from a pile that accumulates in the summer.

Q. 16. State how any tan accumulates in the summer, and to what extent.

(Same objection.)

A. We don't require as much fire in our currying shop in the summer, in consequence of not heating our building; the quantity accumulating I could not give accurately, but I should think about one hundred cords; we use this instead of its equivalent in dry fuel.

(Exhibit No. 13 represents the Sparrowbush furnace referred to.)

Q. 28. Suppose, instead of having two furnaces in order to get the increased grate surface, you should add two more ovens to the present two-oven furnace of precisely the same construction of oven and flues to boiler as therein contained, how would you then be able to do the work of your said tannery by burning wet tan in such furnace without the use of any dry fuel?

(Same objection and calling for an opinion.)

A. I think probably it might do the work, but I am not satisfied that it would.

Q. 29. What more would be required to make four ovens do the work burning wet tan alone?

(Same objection and calling for an opinion.)

A. I should think that five ovens of the size and construction of ours would do it if we should use wet tan alone; we have always estimated that four would do it, but never was fully enough satisfied to go to work and do it.

Q. 30. What pressure of steam do you keep up when you are in full operation and using live steam from the boilers, as stated by you?

(Same objection.)

A. An average of 55 pounds.

219 Q. 38. Have you any other way of drying wet tan at your tannery than spreading it out in the sun?

(Same objection.)

A. No other way than in spreading it on the ground.

Q. 39. What do you use your centrifugals for?

(Same objection.)

A. For sprinkling the leaches.

Q. 40. Do you recollect a Mr. Plumb calling at your tannery?

(Same objection.)

A. I think I do.

Q. 40A. Mr. Plumb, in the latter part of his answer to the 8th Int., explains a mode of feeding in the wet and dry bark, and states that is your regular way of feeding. What are the facts respecting your feeding the two ovens of that furnace?

(Same objection.)

A. The facts in regard to feeding are these: it is irregular; we have no regular way of feeding; we throw in according to what is needed to make the steam required.

Q. 41. Mr. Plumb, in his answer to the 12th Int., referring to his test of the economical working of your furnace, states that a cord of dry tan was deposited at six o'clock in the morning and another cord of dry tan at twelve o'clock noon; that up to three o'clock p. m. that one and a half cords of dry tan was consumed, with six cords of wet tan. State the facts respecting the use daily of dry fuel.

(Same objection.)

A. The use of dry fuel depends on the weather; we use more in damp, foggy weather than we do in clear weather; we usually bring it in the morning when required; sometimes it is not required; we draw dry tan in a cart with one horse; the body of the cart when filled holds a ton of hard coal; when we burn this parcel of

220 dry tan instead of wood we bring in this cart sometimes twice a day, and sometimes three times; when we bring it in three times it is generally not required in the morning to start with.

Q. 42. Had Mr. Plumb any charge or direction of the operations at the time he was there, or was the tannery running regularly, as is usual, from day to day?

(Same objection.)

A. He had no charge to my knowledge, and I presume it was running the usual way.

Q. 43. Mr. Plumb states, in answer to Int. 16th, that you had at that time very nearly 200 cords of dry tan bark stored, ready for use, under shelter. State the facts respecting this matter.

(Same objection.)

A. We never had that amount on hand; I couldn't tell exactly what we had on hand; sometimes we had fifty, sometimes seventy-five, sometimes it run up to one hundred; we never had two hundred; I don't think we ever had over one hundred.

Q. 44. What is the width apart of the grate bars in that two-oven furnace?

(Same objection.)

A. Three-eighths of an inch.

Q. 45. Mr. Plumb, in his answer to Cross 148th Int., states that a quantity of water was allowed to flow freely from the feed pumps into a vessel instead of entering the boilers, and the number of strokes of the pumps noted to give the amount of water, and the number of strokes determined, several times during the day. State whether this test was reliable and accurate, and why it was or was not?

(Same objection and calling for an opinion.)

A. I don't think we stopped our business to let him disconnect the pump from the boilers for the purpose of measuring the water; I don't know of anything of that kind; I don't think the pump accurate enough to be a test; the pump is old, and portion of the
221 time when you think it is working it don't work; often, at times, we have to tinker at it to make it go, and the worm leaks in the heater and leaks in the exhaust.

Cross-examined by Mr. BLACK:

Cross-q. 51. At whose request do you appear as a witness in this case?

A. Jackson Schultz.

Cross-q. 52. Who did you buy this tannery of?

222 A. We understood it to be Maurice M. Schultz.

Cross-q. 53. Did Jackson Schultz have any interest in it?

A. Not that we knew of.

Cross-q. 54. Were either of these furnaces in existence when you bought the tannery, and if so, which?

A. The furnace at the tannery proper; two ovens were there substantially as now.

Cross-q. 55. Did you ever use dry tan as a fuel before you went there?

A. Yes, sir.

Cross-q. 56. In the same form of furnace?

A. Exactly the same, except as to one oven instead of two.

Cross-q. 57. Whereabouts was that, and who built it?

A. At Troy, New York; a mason employed by Mr. Crockett, of Newark.

Cross-q. 58. How many cords of wet tan do you make at your tannery in twenty-four hours?

A. I couldn't tell that possibly.

Cross-q. 59. How many cords of bark do you grind?

A. Between fifteen and sixteen cords.

Cross-q. 60. Tell as near as you can about how many cords of spent tan you make.

A. That's out of my reach; I don't know; I could measure it after it was leached out, wet and ground.

Cross-q. 61. Wouldn't it occupy a smaller compass than when unground and in a dry state?

A. I don't know; I should think it would.

Cross-q. 62. You are not the fireman at either of these furnaces, are you?

A. I am not.

Cross-q. 63. Did you overlook Mr. Plumb when he was making his examination at your tannery?

A. Not particularly.

Cross-q. 64. Have you a room or building set apart specially for the dry tan?

223 A. We have.

Cross-q. 65. Is it a separate building?

A. Not entirely.

Cross-q. 66. More than one room?

A. There are two rooms.

224 Cross-q. 79. How many cords of hard wood have you got on hand now at your tannery?

A. We had thirty-eight cords on the first of January.

Cross-q. 80. What did you get this wood for?

A. We got it for the purpose of using in those furnaces.

Cross-q. 81. When did you get it?

A. Early in the fall.

Cross-q. 82. How many cords did you get?

A. Fifty cords.

Cross-q. 83. How much wood had you on hand when you got that?

A. Not any.

Cross-q. 84. When had you previously bought wood?

A. About a year before that, I believe.

Cross-q. 85. Who did you buy it of?

A. Of Dr. Handford.

Cross-q. 86. How much did you get of the doctor at that time?

A. I forget; I think it was fifty cords we bought the year before.

Cross-q. 87. When did you get that wood of the doctor?

225 A. I think it was in the summer of 1870; drew it in the latter part of the season, near winter.

Cross-q. 88. Can you tell to a certainty what amount of wood you bought of the doctor on this occasion?

A. I think, as near as I can recollect, about fifty cords.

Cross-q. 89. What's the doctor's post-office address?

A. The doctor lives in New York city; his full name is William Handford.

Cross-q. 90. What did you buy this last lot of wood from the doctor for?

A. To burn in the furnace.

Cross-q. 91. Now, haven't you bought wood of other parties within a year?

A. I don't remember of any other.

Cross-q. 92. Are you willing to state that you have not?

A. Not positively; we might have a few cords; I don't remember of any.

Cross-q. 98. In your answer to 13th direct interrogatory, you speak of using the value of one hundred cords of good, dry hard wood annually; what do you mean by that expression?

A. I mean that the amount of partially dry tan and the amount of wood we use in connection with it during the year is equivalent to one hundred cords of good, dry oak wood.

226 ADOLPH FABER DU FAUR, being called and duly sworn as a witness on the part of the defendants, deposes and says as follows:

Question 1. What is your name, age, residence, and occupation?

Answer. A. Faber du Faur; age 44; I reside at Newark, N. J.; my occupation is civil and mechanical engineer and metallurgist; my office is at 90 Broadway, New York city.

Re-cross:

Cross-q. 221. Is not a furnace with a very large grate very objectionable?

(Objected to as indefinite.)

227 A. A furnace with a very large grate surface is objectionable, and it is the common practice where large grate surfaces are required to use several independent grates.

Cross-q. 222. Why is a large grate objectionable?

(Objected to as immaterial.)

A. Because the firemen would not be able to reach the different parts of the furnace, and in case of arched furnaces the arches would either not be strong enough, or the distance from the grate to the arch would be too large; there are other considerations about the construction of grate bars, but the difficulties in that respect can be obviated; the proper distribution of the air also would be less certain; there may be some other considerations that I cannot think of just now.

Cross-q. 223. Is a very large grate objectionable, except when you have a thin fire?

A. The size of a grate is practically limited by the convenience

of reaching the different parts of the same, even in case the fire is not thin.

Cross-q. 224. In case the fire is thin, what is the objection to a large grate?

A. You would have to keep the fire door open all the time to properly supply it; all this depends upon the kind of fuel used, and varies with the nature of the fuel.

Cross-q. 225. Is not the objection to a large grate and thin fire, that parts of it are liable to become uncovered, and that a large volume of air is liable to pass through unconsumed?

(Objected to as too general and indefinite.)

A. From my former answer to cross-q. 221, it is evident that I understood the question to be whether large grate surfaces, if such are required for certain purposes are objectionable; I stated that they are; I understood this question to refer to the use of several furnaces for one boiler; if the question had been put to me, whether for the consumption of a certain quantity of fuel per hour an unusually large grate surface would be objectionable, I should have said it is;

228 with ordinary coal, according to my recollection, not less than four pounds of coal ought to be burned on a square foot of grate surface; in giving such figures I am in the habit of referring to my books or notes; with too thin a layer of fuel and slow combustion, it is, of course, difficult to keep the whole surface in the same condition necessary for perfect combustion; there may be an excess of air passing through at one time; at another time there may be a deficiency which is still more injurious.

Cross-q. 226. Do you know the calorific power of different kinds of fuel?

A. I generally refer to my books, and I must confess I am entirely unable to give figures from memory with certainty; I know that one pound of coal will evaporate from eight to eleven pounds of water, the theoretical value being in the neighborhood of from twelve to fourteen; I think wood with about twenty per cent. of water would evaporate about four pounds.

Cross-q. 227. Why is there such a difference between the evaporating power of coal and wood?

A. Partly owing to the chemical composition, and partly to the water contained in the wood.

Cross-q. 228. Has the coal any water?

A. Sometimes it has.

Cross-q. 259. Look at "Box on Heat," page 34, and state the calorific power of one pound of coke, also one pound of wood containing twenty per cent. of water, as given in that work?

A. Box gives for coke, eighty-five per cent. of carbon without any hydrogen or oxygen, ten thousand nine hundred and seventy units of heat; for wood, with twenty per cent. of water, five thousand two hundred and sixty-five units of heat to the pound.

Cross-q. 230. How many units of heat could be obtained, taking

the above as a data, from one pound of wood containing sixty per cent. of water?

A. About 2.632.

229 Cross- q. 231. How many pounds of water will one pound of wood containing twenty per cent. of water, heat from the temperature of 32° to 212° Fahrenheit?

A. It will heat about thirty-one pounds of water from 32° to 212° Fahrenheit, if there is no loss; under ordinary circumstances not over eighty per cent. could be expected.

Adjourned to Tuesday, Jan. 30, 1872, 11 A. M.

JANUARY 30, 11 A. M.

Parties present as before.

Re-direct:

230 Q. 235. Having reference to sections 101 and 119 of Box on Heat, referred to by counsel for complainants, would such statements therein contained lead to the inference that feeding in at the doors above the grates would be inferior to feeding on at the top?

(Same objection.)

A. They would not, if the supply of air is properly regulated.

Q. 236. Will you please state why but one-half the number of units of heat are obtained in the case cited in cross-interrogatory 230, of the number of units obtained in the case cited in interrogatory in 229?

(Same objection.)

A. One pound of wood with twenty per cent. of water contains 0.8 (eight-tenths) pounds of perfectly dry wood; one pound of wood with sixty per cent. of water contains only 0.4 (four-tenths) of perfectly dry wood, or one-half of what wood with twenty per cent. of water contains, wherefrom it follows that the heat developed will be but one-half.

Q. 237. Are the results given by you in answer to cross-interrogatories respecting the combustion of different fuels theoretical, and do you find on examination that they agree with the figures given in Box on Heat?

(Same objection.)

A. They are theoretical; practically only from fifty to eighty per cent. of this is obtained; taking for a rough estimate one thousand units of heat for evaporating one pound of water, the ten thousand nine hundred and seventy units of heat from one pound of
231 coke would give about eleven pounds of water evaporated theoretically; eighty per cent. of which would be 8.8 (eight and eight-tenth) pounds; in the same way it would be shown that wood with twenty per cent. of water would practically evaporate about four pounds under the most favorable circumstances.

Q. 238. Will you please state if you have made the calculation

about what a chimney would require in brick, such as was intended to be referred to in the cross-interrogatory 89?

(Same objection.)

A. About 50,000, not including the foundation.

Q. 239. About what would be required for a foundation of brick for such a chimney?

(Same objection.)

A. That would depend on local circumstances: it might be from 25,000 to 30,000.

Q. 240. What would be the probable cost of such a chimney and foundation?

(Same objection.)

A. At twenty dollars per thousand for brick when laid it would be from $1,500 to $1,600.

FEBRUARY 1st.

Parties appeared with counsel as before

Examination of A. FABER DU FAUR continued, and in answer to questions proposed by C. N. Black, esq., on further cross-examination, the witness testified as follows:

Re-cross:

Cross-q. 241. What kind of chimney had the furnace at the Laporte tannery, brick or iron?

232 (Objected to as immaterial.)

A. An iron chimney.

Cross-q. 242. What kind of chimney had they at the Thorndale furnace, brick or iron?

(Same objection.)

A. Iron.

Q. 245. Of the heat generated in the cases referred to by you in your 236th int., state what percentage of heat generated could be utilized in either case for the making of steam?

(Same objection.)

A. For wood with twenty per cent. of water the (0.8) eight-tenths pounds of dry fuel contained in one pound has already evaporated (0 2) two-tenths of water contained in the fuel, which must be subtracted from the total theoretical evaporative power. In the case of wood with sixty per cent. of water (0.6) six-tenth pounds must be subtracted from the total theoretical evaporative power; after these quantities are deducted, the evaporation which

233 practically may be obtained will be from fifty to eighty per cent.; taken in round numbers the theoretical value for evaporation of wood with twenty per cent. of water at five pounds, and deducting 0.2 pounds it leaves 4.8, or ninety-six per cent.; for wood with sixty per cent. of water, the theoretical evaporation of water would be 2.5 pounds, and deducting the 0.6 would leave 1.9 pounds, or seventy-six per cent. for the theorectical evaporation; what would be obtained practically depends on circumstances, but at

all events the per centage, other circumstances being equal, will be smaller for the fuel containing the greater amount of moisture.

Q. 246. Have you yet received Hollunder's work, and if so, will you please produce it for identification, and give a translation of the text, and a reference to the plates which have any bearing on fire-brick grates and hot ash pits?

(Same objection.)

A. I have received it since I was last examined, a few days ago, and I here produce the book for identification, and this paper is a translation of parts of the book refering to fire-bricks and hot ash pits, which I herewith present.

234 SATURDAY, *January* 6, 1872.

Met pursuant to adjournment.

Present—Counsel on both sides.

JACKSON S. SCHULTZ, called and sworn as a witness on the part of the defendants, deposes and says:

Question 1. What is your name, age, residence, and occupation?

Answer. Jackson S. Schultz; I am fifty-six years old; I reside in New York city; leather dealer and tanner; I am of the firm of Schultz, Southwick & Co.; I have been a tanner for thirty-five years.

Q. 2. Have you a knowledge of the burning of wet tan at tanneries; if so, state how it was commenced to be burned, and any changes in the mode of burning it that took place subsequently?

(Objected to as incompetent, as irrelevant, immaterial, and improper on rebuttal.)

A. I have; previous to the years 1848 and 1849 it was burned on ordinary grates, with certain modifications under the boilers in the same manner as wood and coal were and are burnt; those modifications of grate construction were very numerous; the principal and most sucessful form used was the perforated cone grate; this model, defendants' Exhibit No. 13, is not drawn to a scale, but is rather a rough model, made by a carpenter, without reference to the proportion of the parts; about this time, or within a month or two of it, I saw in Newark, N. J., in the patent leather manufactory of W. & O. Hoyt, then under the charge of D. B. Crockett, the furnace represented by model marked "Defendants' Exhibit No. 6;" the next furnace I saw was constructed by a firm in which I was interested, at Glenwood, Pa.; that furnace was a double furnace, that is to say, it had two doors in front and two ash-pit doors similar to the last-named model, but instead of perforated grates it had the ordinary grate bars of three-eighths of an inch apart; this, I think, was in the year 1854; about the same time, or a little later in that year, I caused to be erected at Homowack, Ulster county, a furnace for burning wet tan, similar in most respects to defendants' Exhibit No. 5, the object of which was to heat tan liquors in a pan; from and

after the time of these successful tan-burning ovens they multiplied very rapidly, and almost all the tanners in the country adopted them in some of their forms of construction; in regard to the construction of furnaces, I would say they were seldom, if ever, constructed alike, but they vary with the varying conditions under which they are introduced; particularly was this true of all those ovens put into old tanning establishments; sometimes they are built square, sometimes oblong, sometimes single, sometimes double, sometimes they feed from the top, sometimes from the front.

235 Q. 4. State what was burned, as a fuel, in the ovens of the furnaces which you saw at Hoyts'—Woodstock, Newark—Sparrowbush, and at Glenwood, as testified to by you?

(Same objection.)

A. On all occasions when I was present they were burning exclusively wet tan from the leaches, with the exception of the ovens in Newark of W. & O. Hoyt, and there they were were burning wet sumac and wet leather scraps with the wet tan; and I was informed by Mr. Crockett that at times, when they were not supplied with these materials, they used dust of anthracite coal, but that such refuse coal was of inconsiderable value, and was only used when they were short of the other material. With reference to the tan consumed at Sparrowbush, N. Y., I have to say that I have observed for hours, and even days, the burning of wet tan exclusively in those ovens, and the same remark is true of the Glenwood ovens, having spent long periods of time at both of these establishments. With reference to the furnace at Woodstock, I have to say that I was there but a short time, and my observation was confined to that period. The periods of which I speak of this observation was first at Sparrowbush, in June or July, 1853, and, I think, at Woodstock, in July or August of same year; in Newark, in August or September of same year; at Glenwood, I think it was in the year 1854, and at Homowack before the year 1855.

(What the witness was told as hearsay, objected to.)

236 Q. 20. Have you knowledge of wet tan being burned on cone grates under the boilers, and of its still being so practiced; if so, with what success?

(Same ojection.)

A. I have such knowledge, and up to the year 1851 and 1852 it was, as I have already stated, the uniform practice, and very many or most of the small tanneries, as I have stated, in New England, still practice the same method. The most remarkable instance within my knowledge is that of Bush & Howard, at Wells-

237 ville, N. Y., who constructed a first-class tannery at that place, about the year 1858 or 1859, and after making full inquiry in regard to the merits of tan-burning ovens, adopted the old method and burned wet tan successfully for eight or nine years, as I am informed. In the year 1859 I visited their tannery, which was then considered the largest tannery in the United States, and by everybody conceded to be the model tannery then known. They

were burning wet tan on cone grates under their boilers, with a high brick stack, and so far as I could judge from inspecting it on two or three occasions within that year, it appeared to me to do the work of that large tannery successfully. The fact in regard to this latter method of burning wet tan no doubt is this: that there is not so perfect a combustion when burned under the boiler as when burned in ovens, but so far as the economy to the tanner is concerned, it is not material, as by neither of the methods can the whole of the spent tan be consumed. Besides, the method of burning under the boilers requires much more boiler capacity and much larger grate surface than when burned in ovens. I understand that they have continued the same practice up to within a year or two, and have within that time added one or two more boilers. Whether they generate steam in these two boilers by the same method I do not know. I think this same method of burning under the boilers is practiced by Rumsey, at Buffalo, and several other large tanners at that place. I would state in general that by far the greater number of tanners in the United States are to-day burning wet tan as they did formerly—namely, under the boiler on perforated iron, cone or other grates.

(Answer objected to by complainants' counsel as irresponsive, hearsay, and giving an opinion.)

Cross-examined:

Cross-q. 238. What kind of grate bars have you in that 8-oven furnace at Wilcox?

A. Fire-brick grate bars.

Cross-q. 239. Who built that furnace for you?

A. Meagley built the 8-oven furnace.

Cross-q. 240. Do you mean John A. Meagley, of Binghamton?

A. His name is Meagley, and I think he lives at or near Binghamton.

Cross-q. 241. How long has that furnace been built?

A. I think about four years.

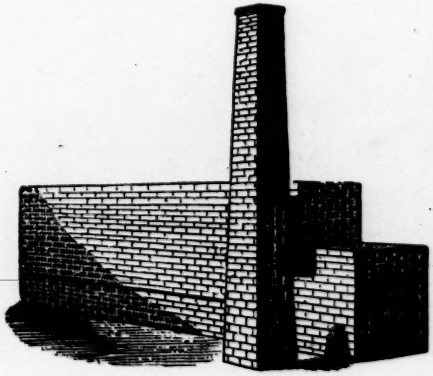
[Here follow 3 sheets of drawings marked pages 238, 239, and 240.]

241 IN EQUITY.

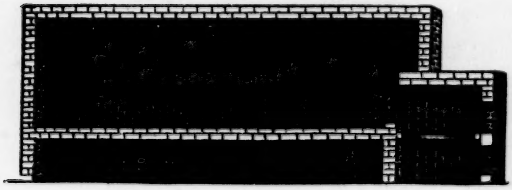
To the honorable the justices of the United States Circuit Court for the southern district of New York, sitting in equity:

Charles N. Black, as he is administrator of the estate of Moses Thompson, late of Boston, in the county of Suffolk, in the commonwealth of Massachusetts, deceased, intestate, a citizen of the state of New York for the southern district of New York, and Eliza W. Fitzgerald, as she is the administratrix of William P. N. Fitzgerald, late a citizen of the city, county, and state of New York, deceased, against Samuel Thorne, James McFarlane, and Jonathan Thorne,

Defendants' Exhibit, No. 5.



Woodstock Furnace—(Front View).



Woodstock Furnace—(Sectional View.)

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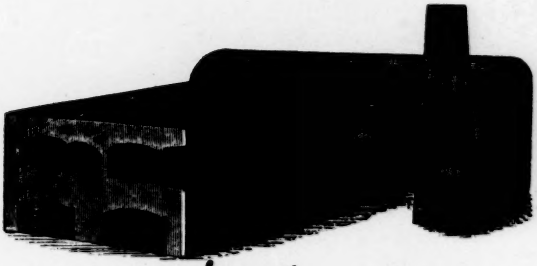
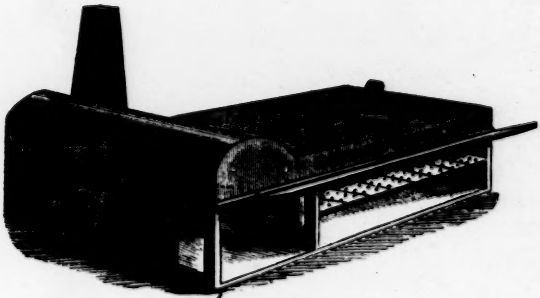
Defendants' Exhibit, No. 6.



or Newark
CROCKETT FURNACE—(Front View).



or Newark
CROCKETT FURNACE—(Side View).

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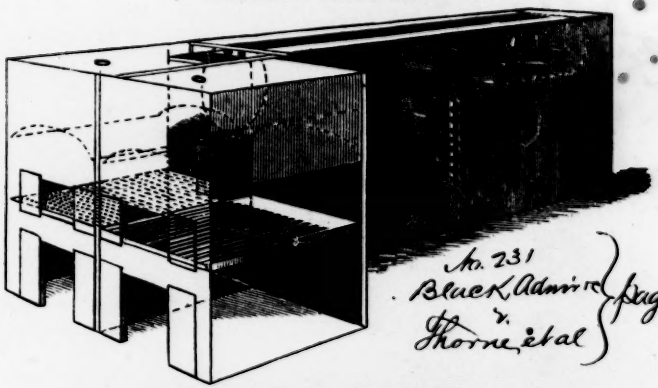
DRAWING OF MODEL

Defendants' Exhibit. No. 13.



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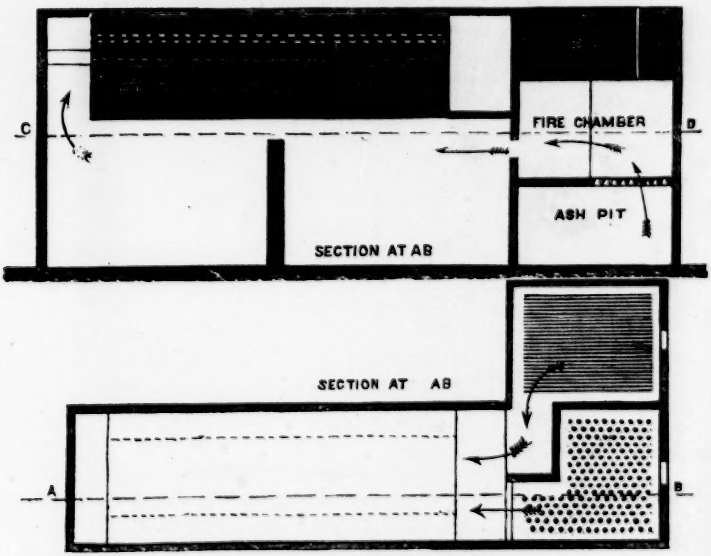
SPARROWBUSH FURNACE—(Ovens in Outline).



SPARROWBUSH FURNACE—(Sectional Views).

jr., all of the city, county, and state of New York, copartners in business under the firm name and style of Thorne, McFarlane & Co., within the southern district of New York; and therefore your orators complain and show that on or about the 11th day of September, 1869, your orators exhibited their original bill of complaint in this honorable court against the said defendants, thereby stating, among other matters, that on the 15th day of December, 1857, letters patent of the United States, bearing date on that day,
242 were issued to Moses Thompson according to law, whereby there was granted and secured to the said Moses Thompson, his heirs, administrators or assigns, for the term of fourteen years from said 15th day of December, 1857, the full and exclusive right or privilege of making, constructing, and using and vending to others to be used certain new and useful improvements in *bagasse* furnaces, and that the said defendants were unlawfully and wrongfully making, constructing, and using said inventions and improvements as therein alleged, to the wrong and injury of your orators as therein set forth.

And your orators further show by way of supplement that Charles N. Black, as such administrator, one of your orators, petitioned the Commissioner of Patents of the United States of America, in accordance with the statute of the United States in that behalf made and provided, for the extension of the patent granted to the said Moses Thompson, December 15th, 1857, and that the said Commissioner of Patents did thereupon, in accordance with the power
243 vested him, on the 14th day of December, 1871, extend and renew said patent for the term of seven years from and after the 15th day of December, 1871, and that the said patent has now the same effect in law as though the same had been granted originally for the term of twenty-one years.

Wherefore your orators pray for the same relief under said extension as prayed for in said original bill.

And your orators will ever pray.

CHAS. N. BLACK,
Sol'r for Compl'ts.

UNITED STATES OF AMERICA,
Southern District of New York, } *ss.*

On the 26th day of June, 1872, personally appeared before me Charles N. Black, administrator of the estate of Moses Thompson, one of the complainants, who, upon being duly sworn upon oath, deposes and says that all and singular the allegations of the foregoing supplemental bill are true of his own knowledge, except so
244 far as they are set forth upon information and belief, and such matters he verily believes to be true.

CHAS. N. BLACK.

Sworn to before me this 26th day of June, 1872.

BENJAMIN W. BUCHANAN,
Notary Public, (81,) *New York County.*

Filed July 1st, 1872.

245 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Monday, the twentieth day of May, in the year of our Lord one thousand eight hundred and seventy-two—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et al. } In equity.

The above entitled cause coming on for final hearing on pleadings and proofs—

Mr. Charles N. Black is heard in behalf of the complainant.

246 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Tuesday, the twenty-first day of May, in the year of our Lord one thousand eight hundred and seventy-two—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et al.

The above entitled cause being still on hearing—
Mr. Andrew J. Todd commences his argument in behalf of the defendants.

247 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Wednesday, the twenty-second day of May, in the year of our Lord one thousand eight hundred and seventy-two—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et al.

The above-entitled cause being still on hearing—

Mr. Andrew J. Todd continues his argument in behalf of the defendants.

248 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Thursday, the twenty-third day of May, in the year of our Lord one thousand eight hundred and seventy-two—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et al.

The above-entitled cause being still on hearing—

Mr. A. J. Todd concludes his argument in behalf of the defendants.
Mr. C. A. Seward is heard in behalf of the defendants.

249 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Friday, the twenty-fourth day of May, in the year of our Lord one thousand eight hundred and seventy-two—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et al.

The above-entitled cause being still on—

Mr. Charles N. Black is heard in behalf of the complainant.

(Further hearing adjourned to Monday, the 27th inst.)

250 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms in the city of New York on Monday, the twenty-seventh day of May, in the year of our Lord one thousand eight hundred and seventy-two—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, administrator,
vs.
SAMUEL THORNE et al.

The above-entitled cause being still on hearing—
Mr. Clarence A. Seward is heard in behalf of the defendants;
Mr. Charles N. Black closes in behalf of the complainant.

Curia advisari vult.

Circuit Court of the United States, southern district of New York.

CHARLES N. BLACK, administrator, &c., of MOSES THOMPSON, and ELIZA W. FITZGERALD, as administratrix, &c., of WILLIAM P. N. FITZGERALD,
vs.
SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, jr.
} In equity.

Chas. N. Black, for complainants.
A. J. Todd and C. A. Seward, for defendants.

BLATCHFORD, J.—This suit is brought on two patents. This first is a reissued patent granted to Moses Thompson, March 31, 1857, for an "improvement in furnaces for burning wet fuel," the original patent having been granted to him as inventor April 10, 1855, and re-issued to him October 7, 1856. The application for the original patent was filed November 14, 1853, the specification having been sworn to November 9, 1853, and a caveat, describing substantially the invention patented, was filed August 12, 1853. This patent was extend April 8, 1869, for seven years from April 10, 1869, by the Commissioner of Patents.

252 The second patent is one granted to the same Moses Thompson, December 15, 1857, for an "improvement in bagasse furnaces." The application for this patent was filed May 13, 1857, a previous application, filed on the same model in February, 1857, having been rejected. On an interference declared between the application of Thompson and a patent granted to A. Hager and S. Allyn for an "improved bagasse furnace," May 6, 1856, priority of invention was decided in favor of Thompson, November 30, 1857. This interference related to what is the second claim in the patent granted to Thompson, December 15, 1857. This patent was on the 14th of December, 1871, extended for seven years from the 15th of December, 1871, by the Commissioner of Patents.

The contest between the parties to this suit has been very severe. The suit was brought after the extension of the 1855 patent, and before the extension of the 1857 patent. The extension of the 1857 patent was strenuously opposed by the same parties who have conducted the defence of this suit, and on substantially the same evidence, on the question of the novelty of the inventions covered by that patent, which is adduced on the same question in this suit. It appears, from a paper in evidence, that seventeen different persons and firms, including the defendants, representing 38 tanneries, including the three tanneries involved in this suit, have joined together to resist the claim of the plaintiffs under the said patents, agreeing to share pro rata all legal expenses incurred in defending

against said patents. The defence of this suit has been conducted under that arrangement.

The answer sets up that the 1857 reissue of the 1855 patent was obtained by Thompson for the purpose of further including therein, and did include therein, more than Thompson originally contemplated, specified or showed to be his alleged invention, on the application for his original patent, and matter which he had no right to include and claim therein, and that such reissue is not for the same invention as the original patent of 1855, but is for inventions and things substantially and materially different. It also sets up that the first claim of such reissue is invalid, because it is indefinite and equivocal, and does not refer to the process specified and described in the language preceding such claim. It avers that the extension of the 1855 patent was obtained by misrepresentation and fraud, and denies any infringement of either patent. It sets up want of novelty in regard to both patents, and specifies, in respect to each, prior knowledge by 19 persons, and prior description in eight printed publications, 14 English patents and two U. S. patents. Twenty-six witnesses have been examined on the part of the defendants, and twenty-one on the part of the plaintiffs. Of these two on each side are chemical experts—Benj. Silliman and Wm. H. Plumb for the plaintiffs, and Chas. F. Chandler and Adolph Faber du Faur for the defendants. The printed case on the part of the plaintiffs covers over 600 pages. That on the part of the defendants covers nearly 1,000 printed pages. The direct examination of the plaintiffs' experts occupied six days and covers 65 printed pages, embracing 76 interrogatories. The cross-examination of those experts occupied 25 days and covers 272 printed pages, embracing 605 interrogatories. The direct examination of the defendants' expert du Faur occupied six days and covers 56 printed pages, embracing 115 interrogatories. The cross-examination of the same expert occupied seven days and covers 67 printed pages, embracing 331 interrogatories. The direct examination of the defendants' expert Chandler covers 15 printed pages, embracing 32 interrogatories. He was not cross-examined. These observations are made for the purpose of showing how thorough has been the investigation of the questions at issue.

The title of the reissued patent of 1857 is, "an improvement in furnaces for burning wet fuel." The specification states the invention to be one of "improvements in burning tan bark, bagasse, sawdust, and other kinds of fuel, in a wet state, for the purpose of creating heat to generate steam, or to be employed in heating or drying operations." Bagasse is crushed sugar cane. There are two figures of drawings accompanying the specification. One is a horizontal section of a furnace constructed according to the invention. The other is a vertical section of the same. The specification states
253 that the main object of the invention is "to effect the more economical use, for fuel, of tan bark, bagasse, or other trashy matter in a wet state, or very green or wet wood." The furnace

shown in the drawings has three fire chambers. The patentee states that he considers three "in many cases to be best adapted to practical operation." He proceeds:

"In some cases two may be sufficient, and in others, more or less. In making these variations as to the number of chambers the builder is to be guided by the quantity of heat required, size of chambers, and character of fuel to be used. The fire chambers are of a square, but may be of other form, with grate bottoms, B B′ B″, and arched tops, or said tops may be used or built of any other form adapted to the kind of fuel to be used. They are separated by a wall of fire-proof material and lined throughout with fire-brick, and, in case of burning wet tan or bagasse, fire-brick grates should be used. Each burning chamber is provided with a door, C, in front, for the purpose of lighting and tending the fire, with an opening, D, at the top, for the purpose of supplying the fuel, and with an opening, E, at the back end of the chamber, which leads to the flue, F, or the mixing chamber. The opening may be provided with a damper, K. Each fire chamber has a separate ash pit, G, below it, which is furnished with a door, H, to regulate the admission of air. The flue or mixing chamber, F, extends across the back of all the three fire chambers, and the chimney may be at one end or may be placed in the rear, with the flue, I, leading to it from the flue, F. If the furnace is used for generating steam the best place for the boilers will be in flue I, which will be made of a proper size to receive and nearly surround it. If used for other purposes any arrangement may be made best adapted to the application of said heat. The thing to be heated ought to be placed a little above the inside top of the mixing chambers. The current from the mixing chamber, in passing to the place of use, should descend or pass under a bridge to the place of use, equal to about one-half of the depth of the mixing chamber, then rise to the place of use. In case of nearly dry fuel, such as green wood and sawdust, the current should rise immediately after leaving the burning chamber, through the mixing chamber, to the place of use, and the flue, E, leading out of the fuel chamber, A, into the flue or mixing chamber, F, should be increased to about threefold capacity of that used for very wet fuels, to be varied in proportion to the wetness or dryness of said fuel. In case of burning of sawdust or green or wet fuel, the chambers should be about double the grate surface of what is commonly used for burning of wood to accomplish the same object; but for wet tan it should be increased sixfold, and the height of the chamber increased, so that the grate may be covered by feeding at the top. The mode of conducting the operation of the furnace is as follows: Fires being lighted in all of the fire chambers with dry fuel, and the masonry heated to a high degree, two of the three chambers, A A′, are fed with wet fuel and have their ash pits closed, and the dampers, K K, partially closed, though this latter is not absolutely necessary. The other fire chamber, having its charge partially dry in the meantime, has the damper K opened, and the door of the ash pit, H, opened far enough to ad-

mit any quantity of air which may be required to promote such a degree of combustion as may be necessary to generate the amount of heat required. There should be no artificial blast, and, if a high stack be used, there should be a damper in it to moderate the draft. When the fuel in the open chamber is reduced to a desirable degree, its ash pit is closed and the chamber recharged and another opened and supplied with air until the fuel within is reduced, when it is closed, recharged, and another opened, each in its turn being opened and supplied with air to generate and supply the requisite amount of heat and carbonaceous gases, while the others are closed and successively supplied with fresh fuel to heat and decompose the same to such a degree as is desirable before allowing rapid combustion to take place. Each fire chamber should be supplied successively with fuel at proper intervals by any convenient means—either through the hole, D, or door, C, in front. The principal advantage of a furnace and process of this description consists in heating the wet charge without unnecessary waste of heat, decomposing it into such gases as will, when mingled in the mixing chamber with the products of combustion from the active chamber, cause the most perfect combustion of the gases and smoke to be effected. This perfect combustion could not be effected in a single fire chamber, but when two or more fire chambers are employed no interruption takes place, and the object is readily attained. Another advantage consists in always holding a certain quantity of heat and highly-heated fuel in reserve in the closed chambers, which may be immediately brought into action by operating one or more of the chambers. A similar but inferior result might be produced by having several grates and ash pits to the same fire chamber, each grate charged successively and its ash pit for the time closed, immediately after fresh charging, to exclude the air. I have described this in my caveat on which my application is based, but do not use it because of its inferiority in practice, although it involves my principle. After ample experiments, I have discovered that any results which can be produced by the use of dry fuel are inferior to wet in proportion to quantity used, and that results like mine can only be attained by the use of wet fuel similar to what I have herein mentioned, fed into an intensely-heated chamber. Under such circumstances the water in the fuel, in the presence of the carbonaceous substances in the fuel, will be decomposed, giving its oxygen to the carbonaceous matter, dispensing with a
254 draft and its cooling and wasteful influence, and rendering the combination so perfect that no smoke is visible. In burning tan and sawdust, where a large quantity of heat is to be made, in order to save the increase of their number, I put the chambers in twice as long as wide, and use two openings, D, to feed through, and thereby accomplish double to each chamber."

Then follows this disclaimer:

"I do not claim the within-described arrangement of a series of fire chambers to communicate with one common flue, irrespective of

the purpose for which, and the manner in which, I employed the said arrangement."

The claims are these:

"1. Using green bagasse, wet tan, wet sawdust, and other wet carbonaceous or vegetable substances as fuel, for the production of intense heat, by mingling the gases issuing from a highly-heated mass thereof with those arising from carbonaceous combustion by the intervention of a flue or chamber, with which the chamber or chambers containing the fire and charge of wet substances communicate, and in which said gases meet, mingle, and consume each other on their way to the apparatus to be heated and to the stack."

"2. The combustion, for the purposes of a high degree of heat, of bagasse, refuse tan, sawdust, and other wet refuse substances, or very wet and green wood, by the employment of a series of fire chambers arranged in any manner substantially as described, to communicate with one common flue or mixing chamber, when any number of said chambers are nearly closed to the admission of air when first charged, as described, while the remaining chamber or chambers is in full communication with the mixing chamber and has a proper supply of air admitted, and the ash pit of each chamber, in its turn, is nearly closed and then opened and has air admitted, whereby the heat required is rendered continuous and comparatively uniform, while the fuel in some of the chambers is being heated and decomposed and its gases sent forward to the mixing chamber to any desirable degree, as herein set forth."

It will be proper, in the first place, to consider the objections that are made to the reissued patent of 1857. It is contended that the first claim of the reissue is void, because the invention claimed in it is not found in the original patent of 1855. That claim is a claim to the use of a flue or chamber intervening between, on the one hand, the chamber or chambers containing the fire of carbonaceous combustion and a highly-heated mass of the wet substances named, and, on the other hand, the apparatus to be heated and the stack, for the purpose of mingling in such chamber the gases issuing from such highly-heated mass with the gases arising from the fire of carbonaceous combustion, so that such gases may consume each other in such flue or chamber, and thus intense heat be produced by the use, for fuel, of such wet substances. The model and drawings of the reissue are the same as of the original patent. Such model and drawings show such a mingling or mixing chamber as is claimed, and show such an arrangement of parts as, when used according to the directions of the patentee, with the fuel named, will produce the result, described in the claim, of mingling and consuming in such chamber the gases mentioned, and producing intense heat. The specification of the original patent of 1855 gives substantially the same directions for producing such results as are given in the reissue of 1857. Those directions are that, taking the use of three fire chambers for illustration, in burning wet fuel two of the fire chambers have their ash pits closed and their dampers partly closed, while

the third fire chamber has its damper open and its ash pit open so far as necessary to produce the requisite combustion in that chamber to produce the degree of heat desired; that when, by such combustion in the open chamber, its fuel is reduced, it is recharged with wet fuel and closed and one of the other chambers is opened for combustion; that so, in turn, each chamber is opened and supplied with air to make it a burning chamber and generate carbonaceous gases, and is then supplied with wet fuel and closed, so as to heat and decompose such fuel before admitting air freely to it; that the chambers are thus supplied with wet fuel in succession; that this carrying out of the process, by using two or more fire chambers, with such a construction of apparatus and flues as is shown in the drawings, will effect the most perfect combustion of the gases generated in the chambers and enable a proper supply of heat to be yielded uninterruptedly; that the use of a single fire chamber will not produce such a perfect result, nor an uninterrupted supply of heat, although an inferior result, within the principle, may be produced by using a single fire chamber, with several grates and ash pits, and charging the several grates in succession, excluding the air from the charged
255 grate until the charge is in a condition for rapid combustion; that, by such use of wet fuel fed into an intensely heated chamber, better results can be obtained than can be from an equal quantity of dry fuel, and that the principle of the operation is, that the products of carbonaceous combustion in the rapid combustion chamber, being present with the gases arising from the decomposition of the wet fuel in the heating chamber, will decompose the vapor of the water, and cause it to yield up its oxygen, so that a perfect combustion will be produced without such a draft being used as had ordinarily been employed for like fuel. All this is disclosed in the specification and drawings of the original patent, and it is repeated in the specification of the reissue. The claims of the reissue are both of them fully warranted by what appears in the specification and drawings of the original patent. The inventor failed to claim in his original patent all that his original specifications and drawings would have warranted him in then claiming.

It is also objected to the reissued patent of 1857, that, as the patentee disclaims the arrangement of a series of fire chambers to communicate with a common flue, irrespective of the purpose for which and the manner in which he employs such arrangement, he cannot lawfully claim the arrangement which he uses, when used for the purpose for which he employs it, and cannot lawfully claim if used in the manner in which he employs it. Fire chambers in a series, communicating with a common flue, existed before, but the patentee's process was not carried out in any of such prior structures, nor was such common flue used as a mixing chamber in any of them. The first claim of the reissue is for a process carried into effect by an apparatus. The prior apparatus would not have enabled the patentee to work his new process, nor was such new process ever worked before in any apparatus. The second claim of the reissue is for an ap-

paratus when employed to work a process, the apparatus and the process being both of them new with the patentee. It is not perceived how any tenable objection can be taken to the validity of either claim. The disclaimer does not admit that the patentee's arrangement existed before, although he disclaims it irrespective of the purpose and manner of his use of it.

Passing now to the patent of December, 1857, the invention therein is stated in the specification to be "improvements in furnaces for using, as fuel, bagasse, wet tan, and other carbonaceous substances too wet to be conveniently burned in the usual way." Five figures of drawings are given—a front view of the patentee's furnace; a sectional side view, showing the interior thereof and the charge of wet fuel, &c.; a front sectional view; a horizontal view of the grate, and a sectional perspective view of the interior. The specification says:

"The leading object of my invention is, to use, as far as possible, the hot vapors driven out of the wet mass, while drying, instead of cold, common air, to support and complete the combustion of the carbonaceous portions of the wet fuel. Bagasse and other wet fuels might be advantageously burned in one furnace, but results are much more uniform and reliable when two are used, discharging their gases into a common mixing chamber, and I therefore prefer to use two or more. The grate surface and the height of the furnace should be regulated according to the kind and wetness of the fuel. The wetter the fuel, the larger the furnace and the smaller the mixing chamber should be."

Then follow directions for the sizes of furnaces for burning bagasse.

"For burning refuse tan and sawdust, I think it better to make the furnace larger and narrower, with two fuel openings on the top, and for a furnace five feet wide and ten feet long, I would make the height from the bottom of the fire chamber to the top of the wet fuel chamber about five feet. The bottom of the grate I would place about two feet above the hearth. But wet fuels differ so much in character and wetness that it is impossible to give precise dimensions. The furnace I propose to describe is particularly calculated to consume bagasse. I build two furnaces side by side, each nearly square in its horizontal section. Toward the top I draw in the wall in such manner as to form a kind of dome, with a sufficient opening at the top to feed the bagasse. The outer walls of these furnaces should be from 24 to 30 inches thick, and built with a special view to rendering them non-conducting. The wall near the top and the partition between the two furnaces may be thinner. In each furnace chamber there should be a partition of fire-brick extending across it from front to back and rising nearly to the top, dividing it into two nearly equal parts. The whole interior of the furnace should be of fire-brick. The main chamber of each furnace should be divided into two parts, upper and lower, by a fire-brick grate about one-
256 fifth the height of the furnace above the hearth, the back end of the grate being a little lower than the front. The bottom

of the lower chamber may be a grate with an ash pit, but a hearth is much better. In each furnace, at the front, on each side of the central partition, immediately under the front end of the grate, should be doors for feeding wood or other dry fuel, and, directly under the doors, at the hearth of the lower chamber, should be draft openings, capable of adjustment to support combustion in the lower chamber. Extending across the back of both furnaces, and opening into both by flues, is a mixing chamber, into which all the gases from both furnaces enter in a highly heated state, and mix and consume each other on their way to the boiler and stack. This chamber should be about one-half the capacity of all the fire chambers, and it should extend down about as low as the back end of the grate. The flue through which the products of combustion pass out of this chamber and under the boiler should be, in section, about one square foot to 40 cubic feet of mixing chamber. The feed openings at the top of the furnaces should be closed by doors which open inwards by the weight of the fuel, but are self-closing and do not yield to pressure from within."

Then follows a description of up and down corrugations in the interior of each upper chamber, on each side, down to the grate, which are stated to be unnecessary in burning tan and sawdust, and to be "for the purpose of allowing the heat to radiate upwards from the fire chamber, for heating the masonry and the wet charge, while the gases or vapors driven out of the wet charge by the heat are allowed to descend to the fire chamber or the mixing chamber."

"The spaces between the grate bars, for burning bagasse, should be about six inches wide for the finest grinding, and twenty inches wide for the coarsest, and should vary between these widths according to the fineness of grinding; but for sawdust and tan much less, say from one inch to three-fourths of an inch. The grate should be made of fire-brick. The operation of my furnace is as follows: A hot fire of dry fuel is kindled in the lower fire chambers of the furnaces, and, after it has been continued until the masonry is well heated, the chamber above the grate is fed with the bagasse or other wet fuel. This hot fire in the fire chamber, especially toward the front of it, under the principal mass of the wet fuel, must be preserved throughout the operation. The heat from the masonry and the fire chamber will be communicated to the wet fuel, which will cause steam and other gases to issue from it and mix with the intensely hot gases of combustion from the fire chambers, and in a short time the mixing chamber will present intense combustion and heat, the dampers of the fire chambers being partially closed. The lower part of the wet charge will, by degrees, become dry and charred, and will fall through the grate, prepared as above, into the fire chambers, and supply, or nearly supply, the place of other dry fuel in preserving the fire in this chamber, and the wet fuel being from time to time supplied will furnish, in a highly heated state, aqueous vapors, which, descending through the corrugations and otherwise into the fire chamber and mixing chamber, will be decom-

posed, furnishing much oxygen to the fire, and supply the oxygen necessary to complete, in the mixing chamber, the combustion of all the combustible gases issuing from the fire chamber. If, by accident, the fire in the lower part of the furnace should predominate, the draft should be diminished, and more wet fuel added; and if by accident the fire in the fire chamber should become too much cooled down, the draft should be let on, and any deficiency of dry fuel should be supplied to the fire chamber. Under proper management little or no dry fuel need be fed to the fire chamber after the operation is fairly commenced. The charred matter falling through the open grate will supply its place, and the caloric thus produced by the combustion of wet fuel will be vastly greater than from the same quantity, by measure, of the same fuel when dry. In the fire chamber, and in the mixing chamber when under intense heat, the carbonaceous gases will decompose the steam from the wet fuel, and effect complete combustion. When the operation is fairly commenced, if the water in the wet charge amounts to, say, 50 per cent. by weight, of the fuel, the dampers of the fire chamber should be nearly or quite closed, to exclude the air. Vapor from the wet charge will then descend through the corrugations and otherwise into the fire chamber, and support the combustion therein, while other portions of the vapor will enter the mixing chamber and complete the combustion there. If the fuel, however, contains much smaller quantities of water, more air in proportion should be admitted at the damper, the object being to admit no more air than will supply the deficiency of the vapor."

Then follow written references to the drawings.

"Little, if any, of the boiler should extend over the mixing chamber. If any considerable portion of the mixing chamber is covered by the boiler, its cooling influence will prevent the decomposition of the vapor and defeat the object of my invention. Great care should be observed in giving proper dimensions to the mixing chamber, for the perfection of the combustion and the efficiency of the furnace depend greatly upon it. The principal object of this chamber is to give the combustible carbonaceous gases
257 from the fire and the aqueous gases from the mass of wet fuel an opportunity of mingling together in such a manner, and under such circumstances, that the aqueous vapor will be decomposed by the carbonaceous gases and its oxygen given out, to complete the combustion of the carbon, without the introduction of air into the mixing chamber, thus saving the caloric previously communicated to the wet charge, while drying it and charring its lower portions and avoiding the cooling influences of cold air. This can take place effectually only in the presence of a high degree of heat, and in the absence of a supply of free oxygen. If this chamber be too small to receive these gases as fast as the furnace is able to produce them, the operation will, of course, be choked and impeded. If the chamber is larger than can be kept densely filled with these gases, of course atmospheric air will be found there at the commencement, and

will continue to find its way into the chamber, and, while atmospheric air is present, the carbonaceous gases will take its oxygen from that principally, instead of decomposing the steam, and the heat in the chamber will be much diminished, and the large quantity of nitrogen —four-fifths—contained in the air, which is neither a combustible nor a supporter of combustion, will at once greatly increase the volume of gases to be sent forward to the stack and proportionately decrease its temperature; and, when the chamber becomes very large, the cooling influences become so great that combustion will immediately cease, and smoke, mingled with steam, oxygen and nitrogen, will go forward, thus wasting the fuel and imparting a faint degree of heat to the boiler. I have therefore fixed the size of the mixing chamber by many careful experiments, and that given above will produce the desired effect with wet bagasse. For drier fuel, producing less vapor, the mixing chamber should be proportionably increased in size to supply the deficiency with air, and to effect complete combustion. Rules more precise would be inconsistent with the nature of the subject. A large and hot fire should always be preserved in the fire chamber below the grate, and directly under the charge of wet fuel, for the purpose of driving the vapor out of it and charring its lower portion, and the grate is left much more open than in furnaces for burning dry fuel of the same size, for the purpose of allowing the charred portions of the wet charge to fall through to supply fuel for this fire as fast as it becomes fit for that purpose, thus consuming the mass with little or no expenditure of other fuel."

The claims are:

1. "The combination of two chambers, the one above the other, and separated by a grate the lower one for the combustion of any known dry carbonaceous fuel, and the upper one, in immediate proximity therewith, to receive heat therefrom for heating and drying the charge of wet fuel, with a mixing chamber, into which both continuously and simultaneously discharge their gases, before reaching the thing to be heated, for mingling and mutual combustion."

2. "In combination with said fire chamber and wet fuel chamber, or drying chamber, making the grate upon which the wet charge rests sufficiently open to allow the lower portion of the wet charge, as it becomes dried and charred, to fall through into the fire chamber and keep a hot fire therein, supplying the place of other dry fuel, while the uncharred portion of the wet fuel is properly supported by the grate till dried, as described."

3. "Placing the mixing chamber of combustion in substantially the same position described relatively to the fire and the wet charge, so that the products of combustion from the dry fuel may pass along the lower part of the wet charge, drying and charring it, on their way to the mixing chamber, and reach it without being in any considerable degree obstructed or cooled by the wet charge, substantially as shown."

It is added: "I wish it distinctly understood that I make no claim

to any of the parts or combinations above specified, except in their application to the preparation and combustion of wet fuels."

The principle developed in the first claim of the reissue of 1857 is worked out in the furnace and method of procedure described in the patent of 1857, but the claims of the two patents are different. The claims of the patent of 1857 are for special constructions to work out more effectually the process of burning wet fuel discovered by Thompson, and made known in his original patent of 1855. The first furnace constructed by Thompson on his principle was built at Richmond, Va., in August, 1853, and was then and there used successfully in burning wet tan. In 1854 he built a furnace on his plan at Weed's tannery at Binghamton, N. Y. Others were built after its pattern at various places in New York, and the furnaces used by the defendants are traced in their origin to the furnace so built at Binghamton. It is very manifest, from the language of Thompson's specification, and from the testimony, that the
258 form of apparatus shown by Thompson in his drawings, and described, admits of many formal variations within the principle of his inventions and the scope of his claims. Thus, a single furnace, with an upper chamber and a lower chamber, separated by a grate, and sufficiently long to admit of two feed holes in the top, with a proper mixing chamber, and operated so as to produce in such chamber the mingling and consumption of the gases from the wet fuel in the upper chamber with the gases from carbonaceous combustion, would infringe the first claim of the reissue of 1857. Such a construction, with the lower chamber used for the combustion of dry carbonaceous fuel, and so operated as to cause the gases from both chambers to be continuously and simultaneously discharged into the mixing chamber for mingling and mutual combustion, would infringe the first and third claims of the patent of 1857. A single furnace, with the grate between the upper and lower chambers so open as to allow the lower portion of the wet charge, as dried and charred, to fall through into the lower chamber, and keep a hot fire therein, the uncharred portion of the wet charge being supported by the grate, would infringe the second claim of the patent of 1857. So, also, various constructions of mixing chambers may be made, which would be substantial equivalents for the mixing chamber of the form and location shown by Thompson, and would be the mixing chamber of each of his two claims in the reissue of 1857, and of the first and third claims of his patent of 1857.

It is satisfactorily shown that the wet tan furnaces of the defendants in their tanneries at Albion, Laporte, and Thorndale, which are the three proceeded against, infringe each of the patents. All of the claims of each patent are infringed by the furnaces at Albion and Laporte; and all, except perhaps the second claim of the reissue of 1857, are infringed by the furnace at Thorndale.

The claims of the Thompson patents are none of them successfully attacked on the ground of a want of novelty. There is nothing in the Crockett furnace, or the Morrison furnace, or the Wood-

stock, Sparrowbush or Newark furnaces, or any of the other American furnaces adduced in evidence, so far as such furnaces are shown to have existed in construction, or in description or drawings, before the dates of Thompson's inventions, which destroys the novelty of those inventions. So far as such furnaces burned wet fuel successfully before Thompson's inventions, to what extent they did, they did so on different principles from those developed by him, and in structures arranged and operated in a manner not embraced in his claims. In regard to all the foreign patents and publications put in evidence, it is sufficient to say that none of them anticipate Thompson's inventions. It is not an unimportant consideration that both of his patents have been extended by the Patent Office, after, as there is every reason to believe, a full consideration of substantially everything on the question of novelty that is brought up in defense in this suit.

It is apparent from the evidence that Thompson was the first to discover and put in practice the true method of economically burning wet fuels, and obtaining from them better results than from equal quantities of dry fuels. In respect to the tanning business, tanners can, by his inventions, certainly obtain all the heat they need by the use of no other fuel than their spent tan, wet from the leaches. The combined resistance by them to his patents is a tribute to the merits of his inventions.

I have examined with care all the evidence taken in this case, and considered the views advanced by the counsel for the defendants, but I am unable to resist the conclusion that the plaintiffs have fully established their case.

As to the point that the cause of action respecting the furnace at Albion arose in the northern district of New York, where that furnace is situated, the objection is one which may be voluntarily waived. The defendants in this case have waived it by not raising it in their answer.

There must be a decree for the plaintiffs for a perpetual injunction, and an account, with costs.

259 At a stated term of the Circuit Court of the United States of America for the second circuit and southern district of New York, held at the court-house in the city of New York on the 1st day of July, 1872—

Present: The Hon. Samuel Blatchford, judge.

CHARLES N. BLACK, administrator *de bonis non* of the estate of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, administratrix of the estate of WILLIAM P. N. FITZGERALD, deceased,

against

SAMUEL THORNE, JAMES MCFARLANE, and JONATHAN THORNE, jr.

This cause having been brought to a final hearing on the pleadings

and proofs, including the supplemental bill hereinafter mentioned, and Charles N. Black, esq., having been heard on the part of the complainants, and A. J. Todd, esq., and Clarence A. Seward, esq., on behalf of the defendants, and the same having been duly considered by the court:

260 Now at this term of said court on motion of Charles N. Black, solicitor for complainants, it is ordered that the supplemental bill verified herein June 26th, 1872, be filed with like effect as if filed prior to such hearing, and thereupon it is found and hereby ordered and adjudged and decreed, and this court, by virtue of the power and authority in it vested, doth hereby order, adjudge, and decree, that the letters patent No. 12,678, granted April 10th, 1855, unto Moses Thompson, now deceased, in his lifetime, for an "Improvement in Furnaces for Burning Wet Fuels," reissued October 7th, 1856, and numbered 398, again reissued March 31st, 1857, and numbered 446, extended April 8th, 1869, and the letters patent No. 18,874, granted December 15, 1857, unto the said Moses Thompson, now deceased, in his lifetime, for an "Improvement in bagasse furnaces," extended December 14, 1871, are good and valid patents, being the patents referred to in complainant's bill of complaint, and that the said Moses Thompson, now deceased, was the original and

261 first inventor and discoverer of the improvements described and claimed in said letters patent.

And also that the said Moses Thompson is now deceased, and that the said Charles N. Black has been appointed his administrator *de bonis non*, and that the said Moses Thompson, on the 19th day of December, 1857, transferred one undivided fifth part of said letters patents to William P. N. Fitzgerald in and for the states of New York, New Jersey, and Pennsylvania; and the said William P. N. Fitzgerald is now deceased, and the said Eliza W. Fitzgerald has been appointed his administratrix; and also that the said Moses Thompson in his lifetime, and the said William P. N. Fitzgerald in his lifetime, and the said complainants, by virtue of the premises, became possessed of and vested with sole and exclusive right and liberty of making, constructing, using, and vending to others to be used the said improvements during the periods of said patents and said extensions; and also that the said defendants are copartners in business under the firm name of Thorne, McFarlane & Co.

262 And also that the said defendants have infringed upon the exclusive rights of the complainants under each of said letters patent and said extensions by making and using furnaces containing the improvements claimed and described in each of said letters patent.

And it is further ordered, adjudged, and decreed that the complainants do recover of the defendants the profits, savings, gains, and advantages which the said defendants have received or made, or which have accrued or arisen to them from said infringement of said letters patent and their said extensions by the making, sale, and use of the improvements described in each of said letters patent.

And it is further ordered, adjudged, and decreed that it be referred to Kenneth G. White, esq., one of the masters of this court, to ascertain and take and state and report to the court an account of the gains, profits, savings, and advantages which the said defendants, or either of them, have received from infringing the said exclusive rights of the said complainants, and the said Moses Thompson and William P. N. Fitzgerald in their lifetime, by the making and sale of the said improvements patented in each of said letters patent.

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And it is further ordered, adjudged, and decreed that the complainants on such accounting have the right to cause an examination of said defendants on terms or otherwise, and also the production of the books, vouchers, and documents belonging to them, or either of them, or to said firm, or under the control, or under the control of either of them, or of said firm, and that the said defendants, and each of them, attend for such purpose before said master from time to time as said master shall direct; and upon the coming in and confirmation of said report, that said complainants have a decree and execution for the amount found due to them, and also for the costs in this suit to be taxed.

And it is further ordered, adjudged, and decreed that a perpetual injunction be issued against the said defendants according to the prayer of the bill.

SAMUEL BLATCHFORD.

264 *Report of Kenneth G. White, U. S. Commissioner, on the damages against the defendants in the Wet Tan Suit.*

Circuit Court of the United States, southern district of New York.

CHARLES N. BLACK, administrator, &c.,
vs.
SAMUEL THORNE et al.

I, Kenneth G. White, the master to whom it was referred by a decretal order of this court dated July 1st, 1872, to take, state and report to the court an account of the profits, gains and advantages which have accrued to or been made by the defendants from the use of the patented invention upon which this suit is brought, do find and report as follows, viz:

First. That the complainant is entitled to receive from the defendants, as profits made by them from the infringement of the patented invention upon which this suit is brought, the cost or value of all the wood which, but for the use of said patented invention, they would have burned in the tanneries owned and operated by them and referred to in the bill of complaint.

Second. That the proofs taken before me on part of the complainant, and not contradicted or disproved on the part of the defendants, show that the saving of wood to the defendants by the

use of said patented invention was one cord of wood for every ten hides tanned by them, less 100 cords per year for a tannery tanning 15,000 hides per year, and a like proportion for a tannery tanning a less number of hides; also less ten cords per year for each tannery, used in the starting of fires.

Third. That, according to the account furnished by the defendants by direction of the master, it is shown that the number of hides tanned by them while using said patented invention was as hereinafter stated in the account hereunto annexed and made part of this my report.

Fourth. That the proofs show that the cost or value of wood per cord to the defendants at the several tanneries owned and operated by them and specified in the bill of complaint, and the cost or value of which was saved to them by the use of said patented invention, was as hereinafter stated in the account hereunto annexed and made part of this my report.

Fifth. That the complainant is also entitled to recover from the defendants interest at the rate of seven per cent. per annum upon the gains and profits made by them from the use of said patented invention in each and every year, said interest to be calculated from the close of each year to the 12th day of July, 1873, the date of this my report, and which interest appears in the account hereunto annexed and made part of this my report.

Sixth. The annexed is a summary of the amount of principal and interest, which I hereby find and report as the amount due from the defendants to the complainant under the aforesaid order of reference in this cause, viz:

Years.	No. of hides.	Cords of wood.	Prices per cord.	Total cost of wood.	Interest Account. Time. Yrs.	Mos.	Days.	Int.	Total.	Grand total.
Laporte:										
1865	2,026	187.60	$1 75	$328 30	7	6	12	$173 12	$501 42	
1866	11,957	1,112.70	1 75	1,947 22	6	6	12	890 39	2,837 61	
1867	11,451	1,058.60	1 75	1,832 66	5	6	12	711 06	2,543 72	
1868	11,254	1,040.74	1 75	1,821 28	4	6	12	557 86	2,679 14	
1869	8,853	820.30	1 75	1,435 42	3	6	12	354 88	1,790 30	
1870	11,512	1,064.27	1 75	1,862 47	2	6	12	330 60	2,193 07	
1871	11,387	1,052.84	1 75	1,842 47	1	6	12	197 65	2,040 12	
1872	4,225	389.37	1 75	680 75		11	12	45 24	725 99	
1873	8,047	745.10	1 75	1,303 92		3	7	24 55	1,328 47	
										$16,339 84
Albion:										
1866	8,734	805.20	3 00	2,415 60	6	6	12	1,104 60	3,520 20	
1867	8,037	740.17	3 00	2,220 51	5	6	12	860 02	3,080 53	
1868	9,002	830.20	3 00	2,490 60	4	6	12	790 29	3,280 89	
1869	5,132	469.01	3 00	1,207 00	3	6	12	298 47	1,505 47	
1870	8,398	773.87	3 00	2,321 61	2	6	12	410 67	2,733 28	
1871	1,631	150.24	3 00	450 72	1	6	12	48 28	490 07	
										14,619 44
Thorndale:										
1869	11,114	1,031.80	1 75	1,805 65	3	6	12	446 55	2,252 20	
1870	21,622	2,008.07	1 75	3,514 12	2	6	12	622 61	4,136 73	
1871	21,448	1,991.87	1 75	3,484 77	1	6	12	373 93	3,858 70	
1872	11,641	1,081.50	1 75	1,891 75		11	12	125 71	2,017 46	
1873	9,985	925.97	1 75	1,718 75		3	7	32 37	1,751 12	
										14,016 21

P. S.—This makes the total amount due the complainant on the 2d day of July, 1873, $44,975.49.

All of which is respectfully submitted.

KENNETH G. WHITE,
Master, &c.

Dated July 12, 1873.

265 [Endorsed:] U. S. Circuit Court; Chas. N. Black, adm'r, &c., et als., agst. Thorne, McFarlane & Co.; the Same agst. Daniel T. Stevens; Report of Kenneth G. White, master; Charles N. Slack, sol'r. for compl'ts.

266 Circuit Court of the U. S., southern district New York.

CHARLES N. BLACK, adm'r., &c.,
vs.
SAMUEL THORNE et al.

Reference under decretal order dated July 1st, 1874.

October 31*st*, 1872.

Present: Counsel for respective parties.

JOHN W. BRACKNEY, sworn on part of complainant, says:

Am a tanner by trade; was in that business on my own account from 1841 to 1868, and before that some twenty years; I have owned four tanneries; the first was the "Smedberg," Greene county, N. Y.; the "Brackneyville," in Susquehanna county, Penn.; the "Great Bend," Susquehanna county, Penn.; and the "Montrose," Susquehanna county, Penn.; I also leased a tannery at Davenport, Delaware county, N. Y.; I owned the "Smedberg" tannery in connection with John Watson, of the firm of Thorne, Watson &
267 Co. We used in all these tanneries wood for fuel for heating liquors to make leather, extracting the strength from the bark. We always used wood in the "Smedberg" tanneries, and up to 1856 or 1857 in the others. When we adopted the Thompson mode of burning wet tan we tanned at "Smedberg" tannery from 15 to 20,000 hides a year, and used from 1,500 to 2,000 cords of wood a year under the old heater system or way of leaching. At Davenport my recollection that we tanned from 10 to 15,000 hides a year, and used about the same amount of wood in proportion as at the other. At Brackneyville from 15 to 20,000 and wood in proportion. At Great Bend about 8,000 hides and wood in proportion. At Montrose from 8 to 10,000 hides and wood in proportion. I have seen the furnaces used by defendants at Laporte, Thornedale, Sullivan county, Penn., and the one they owned at Albion, N. Y. When I first saw them they were all burning wet tan.

Question. If they burned wood at these tanneries instead of wet

tan for the purpose of heating liquor, &c., how much would
268 they require?

(Obj'd to as hypothetical and too general; overruled & exception.)

A. Something less than what I have stated that we used, from the fact that since they abandoned the use of the old heater system it takes rather less wood—one hundred cords a year, perhaps less—for a tannery of 15,000 hides.

After we adopted the Thompson process we burned less than 50 cords of wood a year at each tannery. Perhaps of this 10 cords was used for purpose of starting the fires, and the rest was for heating the building. This wood was all that was necessary. In the Laporte tannery, I think the finishing loft is heated by steam-pipes connected with the boiler. An ordinary day's work for a man in chopping, splitting, and cording wood, such as used generally in these furnaces, would 1¼ to 1½ cords. It is ordinary 4-feet wood. To draw from 8 to 10 cords a day from above the toll-gate to the Laporte tannery would be a good ordinary day's work—8 or 10 loads of a cord each. The distance is between ¼ & ½ mile. There is not much difference in chopping hard wood or hemlock.

269 Cross-ex'd:

From two to five cords could be carted at a load, with double-team, from toll-gate to tannery; a team might make two trips a day, with five cords to a load, in an ordinary day's work; I do not believe that 4 trips could be made in a day, with five cords each; I am speaking of an ordinary day's work; never seen wood carted over this road; do not think a chopper would chop any more hemlock than hard wood; he may a little, but not much; I am making a comparison by burning wood under heaters on the one hand, and the burning of wet spent tan in detached fire-proof oven or ovens, to generate steam in a steam-boiler, on the other; I mean by the Thompson process—the Thompson furnace; the furnace was constructed of fire-brick grating; the arches were about 8 or 9 feet long, and about 4 wide; feed-holes in the top, and ash pits, and furnace doors, and a damper in the stack; this was about all there was of it; the grate opens so that the spent tan fell through and was consumed in the ash pit.

Q. Was there an active combustion in the ash pit of the
270 furnaces which you say you used?

(Objected to, sustained, and exception.)

Always run our furnaces day and night.

Re-direct:

The old system had a heater in each leach, and the new one had a fire under a boiler or pan. I obtained a license from D. B. Simpson, of Binghamton, Thompson's agent.

Adjourned to the 2d Nov'r, at 1 p. m.

NOVEMBER 12, 1872.

Present: Counsel for respective parties.

(Counsel for complainant offers in evidence deposition of Daniel Reynolds, also deposition of L. R. Bunap, taken before John W. Mix, U. S. commissioner, at Laporte, Pennsylvania, Oct. 18, 1872, the same having been taken under an order made by the master allowing either party to take testimony out of this district upon giving notice to opposite party.)

271 JAMES MCFARLANE, sworn on part of complainant: I now produce a statement of the hides sent to the tanneries at Laporte, Thorndale, and Albion.

(Defendant's counsel objects to the hide account as not material, as not being the correct basis for estimating the profit to which the complainants are entitled to, as being indirect and remote. Statement marked Exhibit McFarlane, Nov. 12th, 1872.) Ten thousand of the hides shown by this exhibit at Thorndale are about half finished, and six thousand of the hides shown by this exhibit at Laporte are about half finished. Cord wood at Laporte is worth $1.75. This has been the average value since we have had the tannery there. At Thorndale, slab wood seventy cents per cord since we have had that tannery. The average value of cord wood—I mean hard wood—at Albion while we owned that tannery was $3.00.

(The above statement as to wood was made by agreement between counsel.

This testimony as to wood is taken subject to objection by
272 defendants' counsel as to its materiality.)

Cross-examined:

The present defendants, the firm of Thorne, McFarlane & Co., commenced business February 1st, 1869. The hides shown by "Exhibit McFarlane" previous to that time were owned by another firm, McFarlane & Thorn.

Re-direct:

McFarlane & Thorne are two of these defendants.

Cross:

The interest of Thorne & McFarlane is not the same in the present firm as in the former firm.

(Complainant rests.)

NOVEMBER 19TH, 1872.

Present: Counsel for respective parties.

JOSEPH B. HOYT, sworn on part of the defendants, says:

I have been interested in tanning since 1850. In my early experience we used wood to heat the liquors and later wet spent tan.

Q. How early did you commence to use wet spent tan in the heat-

ing of liquors used in the extracting the strength from the
273 bark, and at what tannery and in what way did you use such wet spent tan?

(Obj'd to; objection overruled and exception taken.)

I burnt wet spent tan prior to 1865. I first used it in July, 1853. I burned it in a fire-brick oven detached from the boiler. It was used at the Woodstock furnace. The heat generated by the burning of the wet tan was used to generate steam in the boiler to operate the engine and heat liquors. We did all the heating of the liquors with the wet spent tan. There were other like furnaces constructed and in public use subsequently. There was one constructed at Newark, N. J., the same in construction, in fall of same year, and also at Shokan, in Ulster county, the fall of same year, where the heat was applied to a pan-heater from out of the oven of the furnace. We used this in Shokan from fall of 1853 to the summer of 1857, and then we put in steam-boilers and made one like the Woodstock furnace. In the spring of 1861 or '62 a like furnace was put in at the Corner tannery. All were like the Woodstock. I have the impression that the Woodstock is still in operation. The
274 Shokan and Corner are not now in operation for want of tanning material. All these furnaces made heat enough for the operation of the various processes and operations of the tanneries. It is not necessary to use any fuel in extracting the strength from the bark; it has been done time out of mind; it is largely done at the present day.

(Counsel for defendants here offers in evidence the testimony taken on part of defendants in this cause for final hearing, so far as the same relates to the matters involved in this reference.)

Cross-ex'd:

Q. Did you ever build a furnace which was fed from the top instead of from the front of the arch, and if so, where?

(Obj'd to as not material; overruled and exception.)

A. I did; the Corner tannery; it had three feed holes on top, they were twelve feet long.

Q. When you fed the feed holes, did you feed it full?

(Obj'd to as immaterial and not cross-examination; overruled and exception.)

275 A. We fed the *tan until it came up to the under side of the hole*, and it formed a cone down to the grate; it was wet tan directly from the leaches; this one was built *in spring of* 1861 *or* 1862; I had an interest in all the furnaces I have named; part of time I was at tanneries, and part of time in New York; prior to 1857 I lived in New York city, since that in Stamford; there is a tannery at Cherryville, Pennsylvania, that does not use heat; I know of one tanner who has operated four tanneries who did not use heat, but I cannot now remember his name; I have seen the Cherryville factory in operation; they do not use at Mr. Barnes' tannery at Bloody Run; I have seen it in operation; we use heat in all ours; we do not heat all our liquors.

Re-direct.

The wet tan was taken directly from the leaches; there was no difference in the operation of the furnace *which fed from the top and the others.*

Adjourned to the 25th inst., at 10 a. m.

NOVEMBER 25TH, 1872.

Present: Counsel for respective parties.

276 HARVEY S. LADEW, sworn on part of defendants:

I saw wet spent tan burned in furnaces in tanneries as early as 1849; it was burned under the boiler on cone grates; it was in Buffalo, in Rumsey's tannery, or Bush & Howard's tannery; I afterwards built a tannery in connection with my brother at Grayville, about 1850 or 1851, with cone grates of about a surface of 5x6 feet; we tanned at that tannery from 15,000 to 17,000 hides a year; when we bought the Flintstone tannery, they were burning wet spent tan under the boilers on a flat common grate of surface of about thirty square feet; they were tanning from 15,000 to 20,000 hides a year at this tannery; I think we used from 1853 to 1857 the pan furnace at the tannery, like the "Woodstock;" we burned the wet spent tan directly from the leaches; we are using now at Ray's Hill tannery, Fulton county, Penn., a furnace similar to one built at Woodstock, in 1853, also one at Emmaville, Flintstone, Cumberland, and Paw Paw; the wet spent tan is taken directly from the leaches.

277 Question. How do the construction of the furnaces you have referred to as being at present in use, also the Woodstock, compare with the lithograph of furnaces now shown you in respect to the boiler, &c.?

Answer. I think they are essentially alike.

(The drawing is marked Exhibit No. 1.)

In the tanneries last enumerated by me, the burning of the wet spent tan did all the work; at the Corner tannery it was the same, and also at Shokan after the use of water power was discontinued.

X'd. Should say we burned wet spent tan on cone grate under boiler at Grayville five or six years, then used furnace built like at Woodstock; did this because we thought it was better, we fed this in front; this was used I think some 7 or 8 years; then we laid the furnace over again and fed from the top, and used this until we sold the tannery; the furnace we fed from the front had a grate surface of about 5x6 feet; the one that fed from the top had three or

278 four feed holes; if it was 16 feet long it had four, and if 12 feet long it had three; the grate surface of this was, if it was 12 feet long 6x12, if it was 16 feet long it would be 6x16; we changed from the one which fed from front to one that fed at top, because it was more convenient to feed from the changed location of the leaches; besides I think it more convenient in my oven to feed

from the top; I do not know whether the feed holes were fed alternately or not.

Re-direct:

The difference in labor in feeding from front or top is very little. If it was 8 feet front it had four doors. If it was four feet wide it had two doors. It was same at Shokan.

Adjourned to 27th inst. at 11 a. m.

NOVEMBER 27TH, 1872.

Present: Counsel for respective parties.

DAVID SWEET sworn, on part of defendants, says:

Am employed by David Decker, Wellsburg, N. Y., in tanning. Have been foreman in the tannery twelve years.

279 Q. State when you commenced to burn wet spent tan in that tannery, and in what kind of a furnace and in what way?

(Objected to as immaterial and incompetent; overruled & exception.)

A. We commenced to burn wet spent tan in that tannery I think in February, 1860, in a furnace 8 feet wide, 5 feet grate bars of iron. The arch in highest point 30 inches above the grate bars on the backside of the grate bars. The oven is built up to the throat, and the throat is 5 inches wide right across the back of the oven, which extends the whole length of boiler. Had an ardinary ash pit. That was fed in front. The temperature of the ash pit was from 40° to 90°. No bridge walls under the boiler. The wet tan was taken from the leaches; that taken from the leaches in front of the oven, was thrown out at night and burned the next day. Never spread any out to dry before it was burned. When we start fires we start with wood. Burnt from 20 to — cords. Our average capacity has been from 9,000 to 10,000 hides a year, and 2,000 to 2,300 cords of bark a year. We heat the liquors as well as the other work

280 of the tannery with this oven. It is rated at 30 horse power; 60 to 65 lbs. steam safety; valve at 77 lbs.

(Counsel for complainant moves to strike out all above testimony, as it relates to matters since the patent to Thompson was issued.

Motion denied and exception.)

A. The tan was in the leaches about eight days and the liquor on it. Fire made it burn in the furnace. It burned as all other fires burn, and for same reasons all other fires burn.

(Counsel for defendant offers a drawing showing a plan of furnace testified to by this witness, which is rejected by the master and exception taken.)

JOHN H. DUSENBURY, sworn on part of defendant:

Am a tanner at Great Bend. Been interested in tanning these 8 years. We use wet spent tan as it comes from the leaches for

fuel. Use no other except when we start fires. We tan about 12,000, and grind 3,000 cords bark, and engine 30 horse power. We use no other power in tannery. The oven was put in fall of
281 1860. Should think average temperature of ash pit to be about 110°. The furnace has perforated cone great bars which have been in 9 years. We feed through doors in front 1x2 feet. The under side of the crown of the arch is five inches higher than the bridge wall, the throat or opening extended clear across. There were no bridge walls under the boilers; the boilers were hung.

(Complainants' counsel objected to all above testimony in due time, and now moves to strike out same as incompetent and immaterial; overruled & exception.)

A. Should say there was no difference in this furnace from ordinary furnace for burning wood or coal. It was first built to burn coal. Made no change in it except the grate. The first grate was a slat grate so that it let the tan through, and we then put in the perforated cone grate. R. G. Stevens owns the tannery. I suppose the draught is what causes the tan to burn.

282 X'd. We also heat liquids from steam generated by this fuel at 65 lbs.; safety valve set at 75 lbs.

Adjourned to the 29th inst., at 11 a. m.

NOVEMBER 29TH, 1873.

Present: Counsel for respective parties.

JOHN STEITWORTHY, sworn on part of defendant, says:

Am employed at Sparrowbush at the tannery of Sweazey, Cooper & Co. as engineer since 1853.

Q. State if you ever burnt wet spent tan alone as a fuel; how early and in what way.

(Objected to as irrelevant and immaterial, and also that testimony in relation to that furnace has been fully given in the records for final hearing; overruled and exceptions.)

We did in fire-proof ovens as early as the latter part of June or early part of July, 1853; they had cast-iron grate bars; one was a cone grate and the other flat iron bars; the bars were about ⅜
283 inch apart, and in the other the cone was full of holes; at first the furnace was fed through holes in the top, and we found it too high to throw the tan, and then we fed it through doors in front; we fed it on top nights, so as to get more tan in to last over night; there was quite a heat in the ash pit when the ashes came through; we continued the use of it till the tannery burned down in 1857 or 1858; the heat generated was used to heat liquors, run a bark mill, hide mill and two leather rollers; the tannery was rebuilt and new ovens put in; when we had no night hand to keep up fire we had to use wood to kindle the fire in the morning; we only used wood to kindle with; we ground about 10 or 12 cords bark daily; after the ovens were rebuilt we burned wet spent tan in them up to the present time; during last six years, since Swazey, Cooper & Co. have

owned the tannery, we have burned a little dry tan; since they have had it we have ground about 16 cords bark a day; they used the wet spent tan also in the currying shop, same kind of oven; have burned wet spent tan alone in that oven for 1½ to 2 years; this was about 4 years ago.

284 X'd. I was the engineer when Mr. Plumb visited the tannery; Chris Heideman was the foreman; don't know that there was anything peculiar about the oven to make it burn wet tan; it was fire-proof; it had fire-clay and fire-brick; I know it was for I made it; got the fire-brick and clay from Amboy, N. J.; the wet tan burned in that oven because it had a good draught and was fire-proof and the heat of the arch; nothing but the heat of the brick and the draught makes it burn; don't know of anything else; the manner of feeding makes some difference; don't burn all the wet tan we make; make more than we can use; we burn some dry tan.

Re-direct:

Engine about 35 or 40 horse power.

DECEMBER 5TH, 1872.

Present: Counsel for respective parties.

A. FABER DU FOUR, sworn on part of defendant, says:

Am professional engineer and metallurgist and expert in patent causes.

Q. Have you run the defendants' furnaces at Laporte and Thorndale in the burning of wet spent tan; also the Sparrowbush
285 furnace in the burning of wet spent tan, and any of the Hoyt furnaces?

A. I have, with the exception of the old furnaces at Laporte, which were not in their original condition when I was there.

Q. How many pounds of water did these furnaces evaporate respectively per cord of wet spent tan used as a fuel and pounds of water evaporated per square foot of boiler surface respectively?

(Objected as incompetent and immaterial; objection sustained and exception taken.)

Q. In the burning of wet spent tan in the Sparrowbush furnaces while you ran it, what operations of the tannery were carried on?

(Objected to, sustained, and exception.)

Q. How does the construction of the furnace at the Sparrowbush tannery, which you so run for burning wet spent tan, compare with the lithograph of the furnace Exhibit No. 1?

(Objected to, sustained, and exception.)

286 Q. Had that furnace a mixing chamber or hot ash pit substantially as claimed in the Thompson patent.

(Obj'd to, sustained, and exception taken.

Counsel for defendants offer in evidence the deposition of Archibald, contained in the complainants' printed record.

Counsel for defendants offer to show the economical working of furnaces which existed prior to Thompson's patent, and similar fur-

naces existing at time when defendants constructed their furnaces and similar furnaces existing at the present day, and substantially different therefrom and worked substantially different from that claimed as his process, as compared to said Thompson's furnace and process.

The master asks counsel if he has any witness present to prove the facts contained in the offer.

Counsel says he has, and he is produced.)

287 A. FABER DU FAUR recalled:

Q. Have you examined the Hoyt or Crockett furnaces, so called?

(Excluded as not within the offer.)

Q. Have you examined and worked the Hoyt & Crockett furnaces, or any furnaces substantially differing from the Thompson furnace, and worked substantially different from the Thompson process, which existed at the time the defendants constructed their furnaces; and if so, will you please state the economical working of such furnaces as compared with said Thompson's furnace and process?

(Obj'd to as incompetent and already asked; objection sustained and exception taken.)

Defendants' rest.

Adjourned to the 6th inst., at 12 m.

DECEMBER 6th, 1872.

Present—Counsel for respective parties.

(Counsel for claimant offers in evidence the proof taken
288 for final hearing in this cause on the part of the complainant.)

Adjourned to the 16th inst., at 10 a. m.

Adjourned to the 20th inst., at 10 a. m.

DECEMBER 20TH, 1872.

Present—Counsel for respective parties.

JAMES FREEMAN, sworn on part of complainant, says:

I have been the engineer of the tannery formerly owned by Hoyt & Ladue, at Grayville, Herkimer county, N. Y., for ten years past, except one year when I was absent. When I went there in 1862 they had a short oven in which they burnt wet tan; it fed from the front door; think size of door was 6 x 10 feet; we were very seldom able to keep up steam by burning wet tan alone; we had to use some wood with it; steam run down when we didn't have wood, so that we could not run the machinery; think we run this oven four years after I went there; then tore it out and put in a different kind; this one we fed through four holes at the top; this oven was

289 16 x 5½ feet inside; used this oven for first six months with wet tan right out the leaches; after that it got out of repair, and we used some wood with tan; used it with wood till we rebuilt it, which I think was about two years; after it was rebuilt it did pretty good work till it got out of repair again and then used wood again, and kept on using wood and tan till we rebuilt it again last October; the steam has run down so that could not work machinery when we burnt wet tan alone in the oven which fed from the top; fed the tan through the feed holes at different times; in first furnace spread the tan about 10 or 12 inches deep on grate bars; in the other one fed through the feed holes till full.

Cross-ex'd:

We tore out the first oven to get a better one; we wanted to get one that would make enough steam to run the machinery; we were doing as much business when we had first oven; we tanned more hides after we got the new one; the second had grate surface of 5½ x 16; had to use wood very often in the first furnace; heated the liquors with the exhaust steam from this furnace when we burnt wet tan alone; I attended the furnace; the reason why this
290 furnace would not give us steam enough with wet tan, was that we had not grate surface enough to put in fuel enough; I think if we had had twice as much grate we could have steam enough burning wet tan.

Q How did the oven which you say you put in in October last correspond with the first one?

(Obj'd to, overruled and exception.)

This furnace put in in October has two 8-foot holes and two ovens 16x6 each. The heat from the ovens went off to the boilers, same way as in the first; we run about double the machinery with this furnace that we did with any of the others; the only difference between this furnace and the first one is that this feeds from top and that fed from front, and this one has two ovens; there were three doors in first oven; the tan was fed in at each of the doors at various interrals; never use any wood in last furnace except to fire up.

Re-direct:

The first furnace could not have been built larger and worked practically, because being built to feed from the front, we
291 could not reach into it far enough to spread the tan if it had been made larger.

Re-cross:

Don't see how we could have put another furnace alongside of it, because you could not get the fire to the boiler; we could have had another boiler with the new oven alongside the other, and then we could have made steam enough, burning wet tan.

Q. How does the Oct'r furnace compare with defendants' Exhibit 1?

(Obj'd to, sustained and exception.)

DECEMBER 21ST, 1872.

Present: Counsel for respective parties.

(Counsel for complainant offers in evidence the record used on the final hearing of this cause.)

Testimony closed.

C. N. Black sums up on part of complainant.

Adjourned to the 26th inst. at 10 a. m.

292 JUNE 9TH, 1873.

Present: Counsel for respective parties.

JAMES MCFARLAND, recalled:

Q. Have you an account of the hides you have tanned at your Laporte and Thornedale tanneries, from the time you rendered an account in this case, and if so, produce it?

A. I can give an account of the hides tanned up to the time the last injunction was served on me, 5th April, that is, from the 25th of July, 1872, to 5th of April, 1873.

Thornedale tannery..... 9,985 hides.
Laporte tannery..... 8,047 hides.

Q. Can you tell the number of hides you tanned at the tanneries from the 25th of July last to the 1st of January last?

A. Not at present.

Q. Have you been using the furnaces in those tanneries that were there previous to the 6th of April last, since that date?

A. Yes.

293 Q. What kind of fuel have you been using in them since that time?

A. Wood.

Q. Haven't you also used wet tan in them since then?

A. No, sir.

Cross:

Q. Why did you substitute wood for wet tan in your furnaces since that date?

A. A notice was served on us by the judge forbidding us burning wet tan.

Q. How much wood do you burn in those furnaces, respectively? (Obj. to as immaterial.)

A. Four-and-a-half cords at the La Porte, and five cords at the Thornedale.

Q. How many hides could you tan in a year by the use of that amount of wood per day?

(Obj'd to as immaterial and improper; the accounting being opened simply to show the hides tanned since the 25th July
294 last, while burning wet spent tan, and also that proper foundation has not been laid for asking the opinion of the witness.

The master directs the witness that he must limit his answer to

the question to the amount of wood burned in the tanning of hides to which the witness has testified to-day.

Counsel for defendants except to this ruling of the master.)

A. We can work 75 hides per day at the La Porte, and one hundred at the Thornedale.

Testimony closed.

295 *Statement of hides sent to Laporte, Thorndale, and Albion Tanneries.*

Laporte Tannery.			Thorndale Tannery.			Albion Tannery.		
Year.	No. of hides.	Av. w't.	Year.	No. of hides.	Av. w't.	Year.	No. of hides.	Av. w't.
1865.....	2,026	21.64	1869.....	11,114	21.61	1866.....	8,734	21.19
1866.....	11,957	21.48	1870.....	21,622	22.36	1867.....	8,037	22.22
1867.....	11,451	22.82	1871.....	21,448	23.11	1868.....	9,002	23.25
1868.....	11,254	24.00	1872.....	11,641	24.42	1869.....	5,132	21.69
1869.....	8,853	21.68				1870.....	8,398	21.73
1870.....	11,512	21.08				1871.....	1,631	22.93
1871.....	11,387	24.15						
1872.....	4,225	21.27						
	72,665			65,825			40,934	

Recapitulation.

Laporte	72,665
T'dale	65,825
Albion	40,934
Total	179,424

New York, *July 25th*, 1872.

[Endorsed:] Exhibit McFarland; Nov. 12, 1872; K. G. W.; M.

296 Chas. N. Black, esq., appears for claimants; A. J. Todd, esq., appears for defendants.

Evidence of Complainants' on Damages.

Daniel Reynolds, being duly sworn, says;

Direct 1. What is your name, age, residence, and occupation?

A. Daniel Reynolds; 50; Laporte; teamster.

Direct 2. Are you familiar with the price of ordinary hard & hemlock wood, as used in furnaces under boilers for steam purposes?

A. I should say I was.

Direct 3. How have you obtained your information, by what kind of experience?

A. I have drawn a great deal and bought some.

Direct 4. What is such wood here at the present time?

(Objected to, as it does not appear what such wood would cost the defendants if they had had to use it in their furnaces in controversy in this suit, and also objected to as not being a correct rule by which to ascertain the profits which complainants are entitled to, if any, by reason of the use of the alleged infringing furnaces.)

A. Hard wood $2.50 and hemlock $2.00 per cord. I have had to pay $2.50 for a cord of four feet hard wood.

297 Direct 5. What has such wood been worth here since 1865?

A. I don't think I could change the price of it; it might be a little difference.

Direct 6. What would such wood have been worth delivered at the Laporte or Thorndale tanneries during that period?

A. They might possibly deliver hemlock at fourteen shillings there. I don't think they could get the hard wood much cheaper there.

Cross 7. Can you state what four-feet wood, such as they use at the Laporte tannery, is worth at that tannery?

A. I can state what I could get it for. I could not get it less than fourteen shillings.

Cross 8. Did you ever offer to buy any wood at that tannery?

A. Yes.

Cross 9. When?

A. A year ago this last summer.

Cross 10. Of whom?

A. Mr. Robert Storment.

Cross 11. Did you buy any?

A. He told me I could have a load of eighteen-inch wood for a dollar.

Cross 12. Then you can buy at the tannery for one dollar a cord of 18-inch wood, and if so, do you think it costs them as much as that per cord if they were to use it as a fuel?

A. I think it costs them that.

Cross 13. Is that all you offered to buy of them at that time?

A. Yes.

Cross 14. Do you know what he would sell you a quantity for; did you ever ask him?

298 A. I never asked him; I asked him if he would let me have a load of wood

Cross 15. Are you prepared to state that it would cost them more than a dollar a cord, if they desired to use it as a fuel; I mean such wood as you think you could purchase for fourteen shillings per cord?

A. I think it would cost them fourteen shillings.

Cross 16. Ho do you make it out that it costs them fourteen shillings?

A. It has to be chopped and drawn; I cannot get a cord of 18-inch wood less than 12 shillings.

Cross 17. How much will you state it costs the Laporte tannery to

chop this wood per cord—such wood as they would use in their furnace, I mean ?

A. I calculate it would cost a dollar a cord—cutting; that is what they did pay for some of it when they started it.

Cross 18. Are you prepared to state that since Thorne & McFarland & Co. have had the tannery that they have paid one dollar per cord for chopping such wood as they would use in their furnace ?

A. I am not prepared to state they did.

Cross 19. What are you prepared to state Thorne, McFarland & Co have paid per cord for chopping such wood as they would use in their furnace ?

A. I am not prepared to state what they have paid; when Lathrop, McFarland & Co. run the tannery they paid one dollar per cord for chopping.

(Counsel for defendants objects to all after the first period of the answer as immaterial and irrelevant.)

299 Cross 20. Then you will not say that it costs the defendants, Thorne, McFarland & Co., as much as one dollar per cord for chopping such kind of wood ?

A. In the spring of the year they have hands doing nothing; then they set them to chopping; when they put it out by contract they would have to pay 14 shillings per cord for chopping and delivering; I won't say it did; I mean what it cost Thorn, McFarland & Co.

Cross 21. Will you state that it costs them as much as one dollar per cord by what they actually pay for the chopping ?

A. I don't think it does quite—not now; labor is cheaper than it was when they first started.

Cross 22. Are you prepared to say that they have paid as much as that in the past—since they have had the tannery ?

A. I don't know much about it since Thorne, McFarland & Co. had the tannery; when Lathrop had it I can answer; I know what I have to pay for chopping and what for wood.

Cross 23. But you can't say what Thorne, McFarland & Co. have paid for chopping and for hauling ?

A. I don't know as they have had any chopped and hauled by the cord; I don't know what they have paid since Lathrop left there.

(Objected to as not.)

Cross 24. (Question repeated.)

A. I don't know as Thorne, McFarland & Co. have let any out by the cord to chop and draw.

(Same objection.)

300 Cross 25. Question repeated.

A. I don't know as they have any done in that way; they hired their hands by the month, and they haul with their own teams; I can't say that they let it out by the job.

Cross 26. Then you mean that you do remember what they have done in this matter, and cannot, therefore, say what it has cost them per cord for the chopping ?

A. They have hired men and do their own drawing, and I cannot tell that it has cost them.

Direct 27. Was the cord of wood which Storment said you *you* could have for a dollar a cord of 18-inch wood in the woods or at the tannery?

A. In the woods.

Direct 28. Then you was to have the wood for a dollar, and haul it yourself?

A. Yes, sir.

Direct 29. What was it worth to haul it?

A. It was worth a dollar for me to go after it, but not to them, as they had not to go so far.

Direct 30. If that cord of wood had been four feet long instead of 18 inches long, what would it cost per cord at that rate, including the hauling?

A. Four 66-100 dollars at this place at that rate.

(Signed) DANIEL REYNOLDS.

L. R. BERUP, being duly sworn, says:

301 Direct 1. What is your name, age, residence, and occupation?

Answer. Lorne Romanud Berup; 34; Muncey Bottom, Sullivan Co., Pa.; tanner.

Direct 2. Have you a tannery at Muncey Bottom, and how far is it from this place?

A. Yes, sir; it is counted 8 miles.

Direct 3. Are you in the habit of getting wood for your tannery?

(Objected to. Same objection made as to 4 interrogatory of Reynolds' deposition.)

A. Yes, sir.

Direct 4. Buying it?

A. I bought it last winter and some a year ago.

Direct 5. Did you ever work at the Laporte tannery; and if so, when, for how long a time, and in what capacity?

(Question objected to as too general.)

A. I worked at the Laporte tannery for a year and five months; I think it was six years ago; I came there in December; I was a tanner or boss around there; I went there in November or December, 1866.

Direct 6. Did you buy any wood when there?

(Objected to, as it does not appear that the defendants, Thorne, McFarland & Co., run that tannery at that time.)

A. I don't recollect that we bought any.

Direct 7. Did you get any?

(Same objection.)

A. Yes, sir.

302 Direct 8. What did you pay for cutting it?

(Same objection.)

A. We *higherd* the men at $26 per month and board; board cost 60 cents a day.

Direct 9. How much will a man cut a day?

A. I gave them as a start to avarage their cord and a half, wet or dry.

Direct 10. What kind of wood was it?

(Same objection.)

A. Hard wood, four feet long.

Direct 11. What did it cost to draw this wood?

(Same objection.)

A. Some cost more, some cost less.

Direct 12. State what any of it cost; give the best idea you can.

(Same objection.)

A. I should think some cost $1.25 and some cost 50 cents; some of it was a good ways from the road, and we had to pitch it.

Direct 13. What was this kind of wood worth at Laporte at that time?

A. I don't know; I was not at Laporte once a month during the time I was there.

Direct 14. What is it worth since that?

A. I don't know.

Direct 15. What is hard wood or hemlock four feet long worth at your tannery?

(Objected to as immaterial.)

A. Hard wood is worth $2.25 per cord, and hemlock about 14 shillings or two dollars.

303 Direct 16. How long have you been the owner of the tannery?

A. I think it is five years last May since I commenced to build.

Direct 17. What has been the price of this kind of wood since then?

(Objected to as immaterial.)

A. I never bought any by the cord until a year ago last winter; I burned slabs.

Direct 18. What does the price of wood depend upon at the Laporte, Thorndale, and your tanneries?

A. Price depends upon the cutting and hauling.

Direct 19. Has the price of labor for cutting and hauling varied since 1865?

A. My men costs me as much now as then.

Direct 20. The price of labor during the last five years has not raised much, then?

A. No, sir.

Direct 21. Have you a abundance of wood in the vicinity of your tanneries?

A. Yes, sir.

Direct 22. Is it as accessible as wood at the Laporte and Thorndale tannery?

A. There is woods nearer my tannery than either one of them.

Direct 23. Same kind of wood as you use in your tannery?

A. Yes, sir.

Cross 24. What does it cost to cut the slabs per cord that you burn?

A. The principal cost in slabs is the hauling; the firemen cut the slabs.

304 Cross 25. How far do you have to haul the slabs?

A. Some 3 miles, some 2 miles, and some one mile.

Cross 26. What do you consider it costs you to haul?

A. Those I haul 3 miles and those 2 miles costs me about a dollar a load, and one mile not over 50 cents or 75 cents.

Direct 27. Is a cord of slabs as serviceable as a cord of wood?

A. It makes a quicker fire, but does not last so long.

Direct 28. Do you mean the relative price of a cord of slabs to a cord of hard wood?

A. I do not.

Direct 29. How many hides do you tan?

A. I tan 12 to 15,000 hides.

(Signed) L. R. BUREP.

305 Circuit Court of the United States, southern district of New York.

CHARLES N. BLACK, as administrator, &c., et al., *versus* SAMUEL THORNE et al. } In equity.

Exceptions taken by the said defendants to the report of Kenneth G. White, esq., one of the masters of this court, to whom the said cause stands referred, made in pursuance of the decree made on the hearing of the said cause, bearing date the first day of July, 1872.

First exception.—That the master erred in finding and reporting in favor of the complainants the whole value of the wood consumed by the use of the "old heater system," so called, for the cost or value of the wood, which, but for the use of said patented invention, the defendants would have burned in the tanneries owned and

306 operated by them, and referred to in the bill of complaint as set forth in the first and second clauses of said master's report.

Second exception.—That the master erred in finding and reporting that the proofs taken before him were not contradicted and disproved, which tended to show the saving of wood to the defendants by the use of the said patented invention to be "one cord of wood for every ten hides tanned by them, less 100 cords per year for a tannery tanning 15,000 hides per year, and a like proportion for a tannery tanning a less number of hides, and also ten cords per year for each tannery, used in starting fires," as set forth in the second clause of said master's report.

Third exception.—That the master erred in finding and reporting as a saving resulting to the defendants by the use of the tan-burning furnaces at Laporte and Thorndale in the burning of wet spent tan, the value of the wood which they would have burned had they used the "old heater system," so called, instead of using said fur-
307 naces, substantially as set forth in clauses 1st, 2nd, and 4th of said master's report.

Fourth exception.—That the master erred in finding and reporting that there is due to the complainants the amount as set forth in clause sixth of said master's report as principal and interest.

Whereas, because of other tan burning furnaces in existence and use prior to and at the time of the origination of the invention of Moses Thompson, as set forth in the proofs before the master, as well as conceded by the opinion of the court, rendered at final hearing, in which wet spent tan was consumed as a fuel, the said master ought to have found and reported that no gains or profits had arisen or accrued to the defendants from the use of said patented inventions upon which the suit was brought.

Fifth exception.—That the master erred in finding and reporting that the complainants are entitled to recover from the defendants interest upon the alleged gains and profits made by them
308 from the use of said patented invention, as set forth in clause fifth of the said master's report.

Sixth exception.—That the master erred in not finding and reporting that the saving due to the said patented inventions on which this suit was brought, and to which the complainants only were entitled, was the cost or value of the dry fuel saved by the use of the said patented inventions, and which would be burned in tanning an equal number of hides tanned by the defendants within the period covered by the accounting by the most economical furnace used in consuming the wet spent tan, according to known principles outside of the alleged patented process, and open to the use of the defendants outside of said patented inventions and process.

Seventh exception.—That the master erred in not finding and reporting that the tan burning furnace at Sparrowbush, N. Y., of the class known as the Sparrowbush furnace of 1853, consumed
309 but one cord of wood for every 520 hides tanned, and that such was all the wood which but for the use of said patented invention the defendants would have burned in the tanneries owned by them and referred to in the bill of complaint in tanning the number of hides stated in clauses 3d and 6th of said report.

Eighth exception.—That the master erred in disregarding proof as to what the furnaces now in existence of that class known as Sparrowbush, Woodstock, Hoyt, Decker's, Wellsburg, N. Y., the R. P. Stevens, Great Bend, N. Y., and other American furnaces, and practically operated in burning wet spent tan, as they were operated prior to the date and origination of said patented inventions, would effect in economy of use of dry fuel or dry wood, when wet spent tan was being used therein as a fuel outside of the said patented pro-

cess, as compared with the furnaces constructed and operated according to said patented inventions.

Ninth exception.—That the master erred in excluding
310 proof of the economy in the evaporative power of the heat generated by the furnaces now in existence of the class known as Sparrowbush, Woodstock, Hoyt, and other American furnaces, and operated as they were operated prior to the date of Thompson's said patented inventions in the burning of wet spent tan, and according to known plans outside of Thompson's process, as compared with furnaces constructed and operated according to Thompson's said patented inventions, in order to show the proper relative saving between the patented inventions and such other furnaces used in the combustion of wet spent tan prior to the date of the origination of said patented inventions.

Tenth exception.—That the master erred in excluding proof of the economy of furnaces used in the combustion of wet spent tan substantially different from the Thompson furnace and worked substantially different from the Thompson patented process, and of the economy of such other furnaces and processes as compared
311 with the said Thompson furnaces and process, and *and* which furnaces were existing and in use at the time that the defendants constructed their tan-burning furnaces complained of.

Wherefore the said defendants except to the said master's report, and they hereby appeal therefrom to the judgment of this honorable court.

A. J. TODD,
Solicitor for Defendants.

Dated Aug. 27th, 1873.

312 [Endorsed:] U. S. circuit court, south. dist. of New York; in equity; Chas. N. Black *et al. vs.* Samuel Thorne *et al.*; copy; def'ts exceptions to the master's report; compared.

313 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Wednesday, the first day of April, in the year of our Lord one thousand eight hundred and seventy-four—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et al.

The above-entitled cause coming on for hearing on exceptions to the master's report—

Mr. Dorman B. Eaton is heard in behalf of the defendants and in favor of exceptions.

314 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Thursday, the second day of April, in the year of our Lord one thousand eight hundred and seventy-four—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc., *vs.* SAMUEL THORNE et al.

The above cause being still on hearing—
Mr. Eaton concludes his argument.
Mr. Black is heard in reply.

C. A. V.

315 United States Circuit Court.

CHARLES N. BLACK, as administrator, &c., and another, *vs.* SAMUEL THORNE and others.

BLATCHFORD, J.—The master was ordered by the decree to take an account of the profits derived by the defendants from the infringement of the plaintiffs' two patents. The infringement proved was by the use, in burning wet tan to make heat employed in and about the tanning of hides, of furnaces containing and employing in their use the improvements covered by the plaintiffs' patent. The defendants used the infringing furnaces to produce heat. They burned wet tan in such furnaces to produce heat. The claims of the plaintiffs' patents are confined to the use of the improvements claimed only to produce heat by the burning of wet fuel. The ascertainment of the profits made by the use of the patented improvements to produce heat by the burning of wet fuel necessarily presents as the question to be determined, what advantage did the defendants derive in producing heat from burning wet tan by the employment of the patented improvements over what would have resulted to them from the use, to produce equally beneficial results in the way of heat, of other methods for producing such equally beneficial results, open to the public and to them, to be used at the time they used the patented improvements? This requires that the inquiry should be limited to the production of heat, and to the production of equally beneficial results in the way of heat, but it does not require that the heat should be produced by burning wet tan alone; it extends to any fuel.

The master, in taking the account of profits, has proceeded on the principle of charging to the defendants as profits the cost or value of all the wood which, but for the use of the patented improvements, they would have burned in their tanneries. The view is that

the cost of the wood was saved, because the wet tan burned cost nothing as fuel, and would otherwise have been useless. This principle is correct, if to obtain equally beneficial results in the way of heat by other open methods would have required the use of wood to the given amount or value. The solution of the question, therefore, involves these inquiries:

First. Whether there was any other open method whereby equally beneficial results in the way of heat could have been obtained, and, if so, what it was?

Second. What would have been the expense of such method in construction, operation, and fuel as compared with the expense of the use of the plaintiffs' improvements in construction, operation, and fuel?

If the first inquiry should require, on evidence, the answer that it was a method which, to produce the equally beneficial results in the way of heat, would require a certain quantity of wood or other article as fuel, then the saving in expense in fuel would be the cost of the wood or other fuel.

Now I understand the above inquiries to involve an investigation into the matters inquired about in a question put, on the reference before the master, by the counsel for the defendants to the witness Du Faur. The question was, whether he had examined and worked any furnaces substantially different from the plaintiffs' furnace, and worked substantially different from the plaintiffs' process, which existed at the time the defendants constructed their furnaces, and if he had, what was the economical working of such furnaces as compared with the plaintiffs' furnace and process. This question was objected to on the part of the plaintiffs as being incompetent and as having been already asked. The master sustained the objection, and the defendants took, on the record, an exception to the ruling. The defendants have also filed an exception to the master's report (exception 10) on the ground that he erred in excluding proof of the economy of furnaces used in the combustion of wet spent tan, substantially different from the plaintiffs' furnace, and worked substantially different from the plaintiffs' process as compared with the plaintiffs' furnace and process, and which furnaces were existing and in use at the time the defendants constructed their furnaces which are complained of. The evidence so excluded ought to have been received. It was competent and relevant. It could not be told *a priori* that the answer to it would introduce nothing which had not already been given in evidence in the case. It does not appear whether the master sustained the objection to the question on the ground that it was incompetent, or on the ground that it had been already asked for, or on both grounds. Where or when the question had been already asked of the witness is not stated in the objection or pointed out in the record. There may have been general evidence given by the witness in the proofs for final hearing as to the working of furnaces substantially differing from the plaintiffs' furnace, and worked substantially different from the plaintiffs' process, which existed at the time the

defendants constructed their furnaces, and which were open to them to be used, and as to the general economical working of such furnaces as compared with the plaintiffs' furnace and process, but the inquiry before the master involved the details of such economical working, with a view to the arriving at the saving in money effected by the use of the plaintiffs' patented improvements. It is no answer to these views to say that the court has held in this case that the patentee was the first to discover and put in practice the true method of economically burning wet fuels and obtaining from them better results than from equal quantities of dry fuel. That is true, but still the difference in economy which the defendants have derived from using the patented improvements is now the subject of inquiry. It may be that equally beneficial results in the way of heat could not have been obtained by the use of any quantity of fuel, wet or dry, or both. It may be that to produce equally beneficial results in the way of heat would have required a certain expense for construction and working, and a certain quantity of a given kind of fuel, costing a certain sum. It may be that the result of all these inquiries will be to show that, after all, the defendants have saved the expense of all the wood it would have taken to produce heat enough for use in tanning the same number of hides which they have tanned by the use of the heat produced by the infringing furnaces, and that with that saving they have still had a surplus of unused heat. If so, the proper inquiry will have been made, and the result arrived at will have been reached on a presentation of all the evidence properly bearing on it.

As these views require the report to be set aside, and the case to be sent back for the taking of further evidence, in conformity with this opinion, an order will be entered to that effect.

316 [Endorsed:] Black *v.* Thorne. Opinion of Judge Blatchford on exceptions to master's report.

317 At a stated term of the Circuit Court of the United States, held at No. 41 Chambers street, in the city of New York, this eighth day of June, 1874—

Present: Hon. Samuel Blatchford, judge.

CHARLES N. BLACK, administrator, etc., and another,
vs.
SAMUEL THORNE et al.

This cause came on to be heard at this term on exceptions taken by the defendants to the report of the master heretofore made herein, and having been argued by counsel, thereupon, upon consideration thereof, it is ordered that the said report of the master in this case, dated on the 12th day of July, 1873, be, and the same is hereby, set aside, and the master proceed to take further evidence under the

original order of reference to him, and that the evidence so
318 to be taken on the question of profits embraced in said former order of reference be addressed to the question of the gains or profits made by the defendants in producing heat from burning wet tan, by the employment of the patented improvements at the defendant's tanneries, over and above the gains and profits they would have made by the use to produce equal beneficial results in the way of heat, of another method for producing such equally beneficial results, open to them to be used at the time they used the patented improvements, and that the master, as to any particular not above defined, be guided by the views set forth by the opinion of this court given on the decision as to such exceptions, and filed April 28, 1874.

SAMUEL BLATCHFORD.

319 *Master's Report.*

Circuit Court of the United States for the southern district of New York.

CHARLES N. BLACK, administrator, &c., et al.,
vs.
SAMUEL THORNE and others.

I, Kenneth G. White, the master to whom it was referred back by a decretal order bearing date June 8th, 1874, do find and report as follows, viz.:

That the subject-matter of this reference was first referred to me by a decretal order of the court bearing date the 1st day of July, 1872, under which order I proceeded, and took the testimony offered by the respective parties, and made and filed my report thereon on the 25th day of February, 1873. That exceptions were taken to said report and filed on the 28th day of August, 1873. That after a hearing by the court on said report and exceptions, the report of the master was set aside, and the matter referred back to him for a rehearing.

The court, in its opinion setting aside the report and referring it back to the master, states the subject of inquiry before the master to be: "What advantage did the defendants derive in producing heat from burning wet tan by the employment of the patented improvements, over what would have resulted to them from the use, to produce equally beneficial results in the way of heat, of other methods for producing such equally beneficial results, open to the public and to them, to be used at the time they used the patented improvements? This requires that the inquiry should be limited to the production of heat, and to the production of equally beneficial results in the way of heat, but it does not require that the heat should be that capable of being produced by burning wet tan alone; it extends to any fuel."

The court further says: "The master, (referring to former report,)

"in taking the account of profits, has proceeded on the principle of charging to the defendants as profits the cost or value of all the wood which, but for the use of the patented improvements, they would have burned in their tanneries. The view is that the cost of the wood was saved, because the wet tan burned cost nothing as fuel, and would otherwise have been useless. This principle is correct, if to obtain equally beneficial results in the way of heat by other open methods would have required the use of wood to the given amount or value. The solution of the question, therefore, involves these inquiries: (1.) Whether there was any other open method whereby equally beneficial results in the way of heat could have been obtained, and if so, what it was. (2.) What would have been the expense of such method in construction, operation, and fuel, as compared with the expense of the use of the plaintiffs' improvements in construction, operation, and fuel." The court further says "that the court has held in this case that the patentee was the first to discover and put in practice the true method of economically burning wet fuels and obtaining from them better results than from equal quantities of dry fuel. That is true, but still the difference in economy which the defendants have derived from using the patented improvements is now the subject of inquiry. * * * * * If the expression of the court in its decision, "*equally beneficial results in the way of heat.*" is to be understood to mean an equal *degree or amount* of heat, then the master is of the opinion and finds from the evidence in the case that no other than dry fuel could produce such "*equally beneficial results in the way of heat.*"

But the master does not so understand or interpret the language or intention of the court. The question before him is, as he understands it, was there any method or means or kind of furnace other than the complainants', which the defendants had a right to use and employ, which would *produce heat sufficient for the practical uses for which the defendants required and used heat*, to wit, the tanning of the number or hides which they tanned. The master finds and reports that there were methods and furnaces other than the complainants' and other than those burning dry fuel alone which would have produced to the defendants "*equally beneficial results in the way of heat*" for the purposes for which the defendants used it, and which methods and furnaces the defendants had a right to use. The court held in its original opinion in this case that certain furnaces, viz., the "Sparrowbush," "Crockett," etc., burned wet spent tan, and to what extent they did, did so in a manner different from the complainants' method or means.

Those furnaces, therefore, or ones constructed in like manner, the defendants had a right to use. The principal witness for the complainants, Prof. Thurston, produced before the master on this last hearing, testifies that he visited this Sparrowbush furnace and saw it in operation, burning "*tan wet from the leaches.*" "Steam made by this furnace was used to drive the machinery of the factory and to heat the liquor." The saving to the defendants or profits made by

them by the use of the complainants' invention or furnace over the Sparrowbush, or any of the other furnaces as to which evidence has been given before the master, has not been proven by the complainants; and, therefore, the master finds and reports that there is no proof before him showing what profit, if any, the defendants have made by the use of the complainants' *improvement*, and, therefore, nothing is to be recovered from the defendants in this action. All of which is respectfully submitted.

KENNETH G. WHITE,
Master, &c.

Dated November 29th, 1875.

320 *Complainant's Testimony taken before the Master.*

United States Circuit Court, southern district of New York.

CHARLES N. BLACK, ad'mr, &c., and ano'r,
against
SAMUEL THORNE and others.

OCTOBER 5TH, 1874.

ROBERT E. THURSTON, called and sworn as a witness on the part of complainants, deposes and says:

I am a professor of mechanical engineering at Stevens Institute of Technology, at Hoboken, New Jersey; my profession is that of a civil engineer; my practice that of a mechanical engineer. I acquired my knowledge of practical engineering in the establishment of Thurston, Green & Co., subsequently Thurston, Garner & Co., and now known as the Providence Steam-engine Company.

I spent much of my time at this establishment. While at school and in college I was employed by them, and engaged with them subsequently to my graduation until the outbreak of the war
321 in 1861. I then entered the United States navy as an officer in the engineer corps, and served on the gunboats Unadilla, Maumee, Pantosie, and the iron-clad Dictator. I was also for one year chief engineer of the United States steamer Chippewa, and was detailed to duty as engineer in charge of the prize steamer Princess Royal. On these vessels I had charge of the management of engines and boilers of various types and sizes up to between 5000 and 6000 horse power as the maximum. At the close of the war I was detailed to duty at the United States Naval Academy as an acting assistant professor of natural and experimental philosophy.

In July, 1871, I accepted the chair of mechanical engineering at the Stevens Institute of Technology, which position I still hold.

I was educated at Brown University; graduated in course, and received a diploma also as a civil engineer. I have done more or less work at times throughout this interval, designing, constructing, and managing steam engines and boilers and other machinery.

I was a member of the International Jury in 1873 at Vienna.

322 Q. Have you examined any furnaces for burning wet tan; if so, state when and where and the result of your observations?

A. I was called upon in August last to examine a number of furnaces in which wet tan was used as a combustible, with a view to acquiring a more accurate knowledge of the principles and practice involved, for the purpose of forming opinions and acquiring facts which might be used in making an intelligent comparison. I accordingly visited and carefully examined the furnace of Swasey, Cooper & Co. at Sparrowbush, near Port Jervis, N. Y.; the furnace of the Mongaup tannery, near Monticello; the furnace of J. B. Weed & Co., Binghamton; that of H. A. Clark at Red Rock, near Great Bend; the furnaces at Stevens 'and Fulmer's tanneries at Great Bend; that of Hill's tannery, Wellsville, N. Y.; those of Bush & Howard at the same place; Wellsville or Genesee; that of Wells & Stratton, near Addison, Steuben co., N. Y., and the furnaces of the defendants in this suit, at Thorndale and Laporte, Pa.

At Sparrowbush I found two furnaces, one of which has already been minutely described in evidence taken in the suit, and the second having the same dimensions, as given by the proprietors, and a different form of boilers. In the first-named furnace they were burning tan wet from the leaches; steam made by this furnace was used to drive the machinery of the tannery and to heat liquor. The second furnace supplied the steam required in the currying, including that needed in heating and drying.

At the Mongaup tannery I found a furnace feeding from the top through a single feed-hole; in other respects the furnace seemed to resemble in general form those subsequently visited as Thompson furnaces; there was, however, no observable fire in the ash pits; the fires seemed to burn rather sluggishly.

(The last sentence is objected to as irrelevant and immaterial; allowed and exception taken.)

At Binghamton I found the Weed furnace, as already described in this evidence, corresponding in construction to the plans known as those of Thompson, and managed, so far as my observation extended, in accordance with Thompson's method; the upper chambers of the several ovens received the wet fuel through feed-holes on top, which were changed alternately; the lower chambers—the ash pits or incineration chambers, as they have been variously termed—were highly heated by fuel falling from above and burning therein; the flame and gases from the ovens, mingling, passed to the rear end of the boilers, where they still retained a very high temperature; then they passed through the boiler tubes to the chimney; the room in which the furnaces and boilers are situated was kept unpleasantly warm by the large amount of heat radiated from the brick-work; steam was blowing off freely from the safety-valve; the dampers were partially closed.

At the Red Rock tannery of H. A. Clark I found a furnace similar in general construction to that of Weed & Co. at Binghamton;

the method of operating was the same so far as observed, steam blowing off freely; also as in the last case; here, however, the lower chamber of one oven had just been cleaned out, and contained no noticeable amount of fire or ashes; the fire in this oven was burning more sluggishly than in those under which the carbonaceous fire was burning; I noticed, further, that the amount of fire existing in the ash pit had an apparently important influence upon the intensity of combustion in the upper chamber and the efficiency of the furnace; both here and at Binghamton the ash-pit doors were so arranged as to make the opening for the entrance of air into the ash pits comparatively small.

At Stevens' tannery, at Great Bend, I found a furnace which has been described as a Crockett furnace; it differed from that at Sparrowbush most strikingly, in having semi-cylindrical grates, or so-called cone grates, through which a considerable amount of
323 fuel was falling in a state of combustion; the amount of fire in the ash pit was very considerable; the fires in the upper portion of the furnace burned freely; the furnaces were fired alternately through two doors in front of each furnace, there being two furnaces; the combustion was far better than at Sparrowbush, as judged by the eye; the only important difference between these furnaces—the Stevens and the Sparrowbush—was, so far as I can judge, this difference in condition of their ash pits.

At Fulmer's tannery I found a single-oven Thompson furnace, which had been put in recently; this was a furnace about fifteen feet in length by four feet in width on the grate, with three feed-holes in the top, fire-brick grates, and heating a tubular boiler; there was a considerable amount of fire in the ash pit; the fire above was burning very finely, the flame running quite back to the rear end of the brick flues beneath the boilers, striking the rear doors of the flues and returning through the boiler tubes; steam was blowing off freely.

At Wellsville I found, at Hill's tannery, a furnace burning tan wet from the leaches, as was the fact in the several cases just described; this furnace had grates semi-cylindrical in form of section, and about seven feet in length; the furnace was about eighteen feet from side to side, and seven feet in depth; the wet tan was thrown in through four doors in the front, and burned quite freely; a large amount of fuel found its way into the ash pit, where it burned, producing a hot fire; a little carelessness on the part of the fireman would here cause the grates to melt down or burn out rapidly; these grates were directly under the boilers.

At Bush & Howard's small tannery I found a Thompson furnace, which was not in use at the time; workmen were engaged in repairing the boiler, [objected to as immaterial and exception taken,] of which several tubes had been injured and some burned out.

(Last sentence objected to as hearsay and irrelevant, and exception.)

At Bush & Howard's large tannery I found a Thompson furnace

having large ovens; this furnace had no fire in the ash pits; they had been raked out, cleaned, and heaps of hot ashes removed were lying before the doors; the brick-work of the furnace was not highly heated as at Weed's; the fires were burning less frequently; I found here a second furnace, similar to that just described as seen at Hill's tannery in its construction; it had shorter grates, and a great deal of fuel had fallen into the ash pits, producing there a hot fire; the furnace was working quite well.

At the tannery of Wells & Stratton I found a furnace similar to that at the Stevens tannery, worked in the same way, and performing similarly; I found here some iron grates which had been burned out.

(Last sentence objected to as hearsay and immaterial, and exception.)

At Laporte and Thorndale I found furnaces similar in arrangement, and, so far as I observed, very similar in method of working to that in the Mongaup tannery; they had brick arches, a single feed-hole, iron grates, and a deep ash pit without fire; tan was burning in them, but not with remarkable freedom. Comparing the furnaces examined I came to the conclusion that the most efficient result in burning wet tan is secured by a system in which the fuel is charged alternately through two or more openings into the furnace, is then surrounded by masses of highly-heated brick-work or other slowly conducting material, at the same time being exposed to heat radiated from fuel burning beneath it, and to the action of heat brought into the mass by the streams of heated gases rising from this latent mass of fuel, and also by the thorough intermixture of products of combustion with those of distillation; I concluded that a less degree of efficiency would be obtained in any case in which any one of these requisites was not secured; that tan might be burned, although with comparatively low efficiency, in a furnace differing from the ordinary steam-boiler furnace only by the possession of some one of these special provisions, I concluded that one of the most important of these provisions was that called the incineration chamber; I concluded, however, that no reliable comparison between any two types of furnace could be made except by experiment; I therefore subsequently took advantage of the first opportunity, and made a careful experimental determination of the efficiency of the Weed furnace at Binghamton as a good representative of the Thompson type of furnace, and of the furnace of Swazey, Cooper & Co. at Sparrowbush, which had been claimed to be a successful furnace and radically different in construction and in its method of operation from the former; the results of these trials were subsequently written out for my own use in instructing my classes at the Stevens Institute of Technology, and I will present them here in the form then given them for use as evidence.

(The memorandum of trial, &c., referred to by witness is put in evidence, and marked Complainant's Exhibit No. 1, Oct. 5, 1874, K. G. W., master.)

Q. Which requires the most steam, the works at Weed's or those at Sparrowbush?

A. The opinion formed by inspection of the two places was that Weed's establishment required somewhat more steam for its machinery, and considerably the most for heating and drying purposes.

324 Q Look at Defendants' Exhibit No. —, June 30th, 1874, and state whether you have read the testimony of Cyrus Whitcombe concerning his furnace, and from his statements and this exhibit, whether or not this furnace described by him is of the same type and description as the furnace of Stevens, at Great Bend, and of Wells & Stratton, near Addison, which you have mentioned.

A. The drawing shows a furnace of a similar type.

Q. What is the action of the grates in these furnaces of Stevens & Wells and Stratton in their use in burning wet tan?

A. The grates in those furnaces have such sizes and proportions of air spaces that they permit a portion of the fuel as it dries to fall into the ash pits, producing there the carbonaceous fire described as a feature of the Thompson furnace.

Q. When you were at Sparrowbush were you shown the dry fuel spoken of by Mr. Cooper in his testimony used in the furnace there?

A. It was shown me by Mr. Cooper.

Q. Did you learn from him about how much of this fuel he used, and what use was made of it in the tannery before they commenced using it in the furnace?

(Objected to as hearsay and immaterial. Overruled and exception.)

A. I remember Mr. Cooper showed me the fuel referred to, stating that probably three or four bushels per day were burned in the furnaces in addition to wet fuel used in summer, and in addition to the stored dry tan, the coal, and the green wood which he had used about the establishment in winter. I do not remember at this moment what he stated he had done with it previously.

Q. Have you read the testimony of Mr. du Faur taken before the master in this case in reference to the examination he made of the evaporating power of this furnace at Sparrowbush?

A. I have.

Q. Does it show how much water passed off from the boilers unevaporated, and were there any means existing when you saw the furnace by which it could be determined before you made your experiment?

A. The report does not indicate how much, if any, water passed off unevaporated, and there were no means, so far as I could discover, previous to my own experiment, by which it could have been determined.

Q. Could you measure the feed water accurately in the manner stated by him in his experiment there?

A. The impression which I derived from reading the printed report of that testimony is that there may have been some error intro-

duced and remained unchecked, but the report is not explicit enough on that point to enable me to speak confidently in regard to it.

Q. How did the fire in the furnace at Sparrowbush compare with the fire in the furnace you saw burning under the boiler at Hill's tannery?

A. That at the latter place looked the best.

Complainants' Exhibit No. 1.

THE "THOMPSON FURNACE" AT BINGHAMTON, N. Y.

1. There were six "ovens," placed side by side, in two sets of three each, the chimney rising between them. The grate surface of each oven was 9 feet long and 4 feet 4 inches wide, giving a total area of 39 x 6 feet—234 square feet. Each furnace was charged through two holes in the top of the furnace arch, the proper method being to fill these holes alternately. The gates were of fire-brick, spaced about three-eighths of an inch apart, and supported along the middle line of the ash pit by a brick wall. The thickness of these grates was nearly three inches. They were in four pieces, breadthwise the furnace, a pair on each side the middle wall, supported by abutting against each other in a manner somewhat resembling an arch of but two voussoirs. Two doors at the end of each ash pit permitted cleaning the ash pit to be readily effected.

The gaseous products of combustion leaving the furnaces entered a mixing chamber, and thence through the flues to the extreme end of the boilers, returning through the tubes to the smoke boxes, and thence through an iron flue to the chimney.

2. The steam boilers were three in number, of the plain multitubular variety; two were 4 feet in diameter, 14 feet in length, and contained 32 4-inch tubes each; the other was 5 feet in diameter, 12 feet long, and contained 78 3-inch tubes.

The total heating surface, reckoning all of the tube surface, one-half the surface of the shell, and all of exposed surface of the tube plates, was approximately 2,000 square feet. Of this a portion was ineffective, the lower tubes being choked with ashes, and the remainder was partly covered with deposit. The chimney was 90 feet high.

3. The feed water was heated by the exhaust steam of the engine driving the machinery of the tannery very nearly if not quite to the boiling point, in a closed heater. The exhaust steam mingled directly with the water. On reaching the tank in which the water was measured, the feed water had cooled down to 205°. Thence it passed through the pump and a considerable length of pipe, across the street separating the engine from the boiler house, and finally around to the back end of the boilers, where branch pipes conducted it to each boiler.

The temperature of the feed when entering boilers could
325 not of course be determined, but it was probably at least as low as 190° Fahr., which is the temperature assumed in the estimate of efficiency, and it may have been somewhat lower.

4. The measurement of the fuel was made as it lay in the leach before it was disturbed, for the purpose of being removed to the boiler house. A careful measurement showed the full leach to contain 8.04 cords of tan. From this 0.34 cord was taken to be weighed after being compressed until it was as nearly as could be judged as compact as when in the leach.

5. Commencing at 9 o'clock a. m., the trial continued until the remaining 7.7 cords were burned, closing at 10 o'clock p. m.

6. The feed water was measured by cutting the feed pipe between the heater and the feed pump, and conducting the water from the former into a wooden box 18 inches wide and 4 feet long. The pump drew the water from this box, which ordinarily stood full to the top. Occasionally the water supply from the heater was shut off, and the time which was occupied by the pump in reducing the level of the water one foot was noted. This was invariably very precisely four minutes. The quantity of water pumped into the boiler from the beginning to the end of the trial was 5,625 pounds, or 90 cubic feet per hour.

7. The capacity of the pump was originally barely equal to the requirements of the case, and, at this time, its valves leaked somewhat, making it necessary not only to run the pump at its full power throughout the trial, but to keep the fires considerably below their maximum intensity, to avoid the necessity of putting on the steam auxiliary pump to prevent the water getting dangerously low; the maximum evaporation on the trial was thus determined by the capacity of the pump; the flue dampers were kept as an average something more than half open; the engineer estimated that he could have burned the fuel with nearly fifty per cent. greater speed, obtaining a proportionally increased evaporation, could the pump have supplied so much water.

8. The spent tan, coming directly from the leach, was so wet as to part with its water when squeezed in the hand, wetting the hand; it had been simply drained a few hours, and was as wet as it could be without dripping.

9. As the result of this trial was considered a matter of great importance, it was essential not only to determine the amount of water entering the boilers, but to determine as accurately as possible the quality of the steam made, thus ascertaining how much water left the boilers as steam, and how much was "primed" over from them unevaporated; as under the conditions of this trial each pound of steam obtained from the fuel about eight times as much heat as was taken up by water "primed" out of the boiler, the serious error which might arise by crediting the fuel with the evaporation of all water entering the boiler, in cases where even a moderate amount of priming occurred, is evident.

Instances sometimes occur in which more water passes off unevaporated than is actually turned into steam; at least one instance has occurred in the experience of the writer in which the average amount of water primed exceeded by more than one hundred per cent. the

weight of steam made; the "percentage of priming," as the expression is used in this paper, being over sixty per cent., an error arising from the neglect of this circumstance telling nearly proportionally in favor of a really very poor boiler.

A good boiler ought not to "prime" when working properly over ten per cent., when unprovided with superheaters; five per cent. priming would represent good work, and as low as three per cent. has been attained.

10. The first precise determination of the amount of priming in steam boilers was probably made by the writer in November, 1871, at a competitive trial of five steam boilers entered at the exhibition of the American Institute, the trial being made at the request of a committee of judges of which he was then chairman.

In that instance a large surface condenser of about 1,100 square feet area of condensing surface was used, in which all of the steam made by the boiler on trial was completely condensed.

A very neat apparatus has been invented by Leicester Allen, of New York city, for determining the quality of the steam furnished by a steam boiler; one of these instruments was made under the direction of the writer for a committee of the American Institute, and was used in 1872, together with the apparatus already described, at the American Institute Exhibition of that year.

11. At the trial about to be described it was impossible to condense all of the steam made, and as no "Allen calorimeter" was obtainable, it became necessary to improvise apparatus for the occasion.

The steam pipe leading to the engine was tapped by a piece of gas pipe on which was fitted a stop valve; from a short piece of pipe attached to this stop valve a length of India-rubber hose was led to a convenient point beside the boiler, where a barrel was mounted on an accurate platform scale; two hundred pounds of water were carefully weighed into this barrel, and when the scale beam precisely balanced, the weight was set ahead ten pounds.
326 A very accurate thermometer which had been provided by the writer completed this crude yet exceedingly satisfactory arrangement.

At intervals during the trial the stop-valve was opened, and, after allowing steam to blow through the hose freely until all water was expelled, and until the hose was so thoroughly heated by the steam flowing through it that it could not produce condensation and render the results inaccurate, the end of the pipe was plunged into the water contained in the barrel, and the issuing steam allowed to condense until the rise of the scale beam proved ten pounds of steam to have been added to the weight originally placed in the barrel; the temperature of the water was carefully observed at the beginning and at the end of the experiment, and the rise of temperature recorded as a basis for the estimates of priming to be given.

12. It was considered advisable to ascertain, if possible, the temperature of the products of combustion escaping to the chimney.

No pyrometer was obtainable, and it became necessary to improvise another special arrangement for this purpose.

A mass of iron weighing sixty pounds was found and placed in the flue leading from the boiler, where it, after a time, attained the temperature of the gases flowing past it.

A wooden vessel of convenient size and shape was obtained, and fifty pounds of water were carefully weighed into it.

At intervals of two or three hours the iron was suddenly removed from the flue and dropped into this water; the initial and final temperature were noted, and, with the range, recorded for use in calculating the temperature of the waste products of combustion.

The pressure of steam was observed hourly.

13. The collated observations gave the following:

DATA.

Mean steam pressure during trial	71.4 lbs.
Total amount of spent tan burned	77 cords.
Total amount of water fed to boilers	73.125 lbs.
Temperature of water entering boilers	190° F.

TEMPERATURE OF WATER IN DETERMINING PRIMING.

	Initial Degrees.	Final Degrees.	Range Degrees.
1st observation	60	110	50
2d observation	63	124 (?)	61 (?)
3d observation	62	115	53

TEMPERATURE OF WATER IN DETERMINING TEMPERATURE OF FLUES.

	Initial Degrees.	Final Degrees.	Range Degrees.
1st observation	65	119	54
2d observation	63	122	59

Weight of one cord wet spent tan as measured in the leach	5,447.7 lbs.
Length of trial	13 hours.

14. The determination of the total heat derived from the cord of fuel is the first and most important problem. To solve it it is necessary to know the temperature of feed water, the weight of feed water, the weight of steam produced and its temperature, the weight of water heated to the temperature of the steam but not evaporated, and the quantity of fuel consumed. From the data obtained we can readily ascertain the total number of units of heat utilized per cord of wet fuel burned.

15. It is first necessary to calculate what portion of the 73.125 pounds of water passed through the boiler was actually evaporated.

Each pound of steam produced required for its generation the quantity of heat needed to raise it from the temperature of the feed

water to that due the pressure under which it was formed, and to vaporize it at that temperature.

Each pound of water, carried away in suspension by the steam, only absorbed from the fuel the amount of heat needed to raise its temperature from that of the feed water to that of the steam.

In heating the water in the calorimeter used in testing its quality, each pound of steam gave up an amount of heat equal to that which would have been required to raise its temperature from that of the mass in the calorimeter, at the end of the experiment, to that of the steam in the boiler, and to evaporate it at the latter temperature and pressure.

Each pound of water entering the calorimeter surrendered a quantity of heat equal to that needed to raise its temperature from the final temperature of the calorimeter to that of the steam under boiler pressure.

16. The total amount of heat being the sum of these two quantities, we may construct an algebraic equation which shall embody all the conditions of our problem*:

Let H = the number of heat units per pound of steam.
Let h = the number of heat units per pound of water.
U = total heat transferred to calorimeter.
W = total weight of steam and water.
X = weight of steam above.
W-x=weight of water above.

Then $Hx+h(W-x)=U$; or

$$X=\frac{U\div h-W}{H\div h-1}$$

17. At the first experiment the steam pressure was 75 pounds per gauge. The temperature of steam at this pressure is 320° Fahr. The "total heat" of steam at 320° Fahr. from 0° Fahr., and at 75 pounds pressure is $(320°-212°)\ 0.305+212°+966°.6=1211°.5$.

The heat transferred to the calorimeter per pound was therefore $1211.5-110=1101.5$ thermal units in this experiment.

The heat transferred per pound of water was $320°-110°=210$ thermal units.

327 The total quantity of heat transferred to the 200 pounds of water by 10 pounds of mingled steam and water was $200\ (110°-60°)=10{,}000$ thermal units.

$$\text{Finally, } X=\frac{\frac{10{,}000}{210}-10}{\frac{1101.5}{210}-1}=8.87 \text{ lbs. steam,}$$

$W-x=10-8.87=1.13$ lbs. water.

* *Vide* Report of Committee on Test of Steam Boilers; Trans. Am. Inst. 1871-72.

The percentage of priming was, therefore, 11.3. The ratio weight of steam and water was $\frac{8.87}{1.13} = 7.85$, the water being $\frac{1.13}{8.87} \times 100 = 12.74$ per cent. of the steam.

18. The other experiments were made with the steam pressure as before, and, in the second, the valve of W-x comes out negative, indicating superheating. This may possibly have actually occurred as a consequence of the water having fallen slightly below the upper row of tubes in one boiler; but it is more probable that the reading, 124°, does not represent the mean temperature of the mass of water in the calorimeter. In this experiment the water was not as carefully stirred with the thermometer as in the other experiments, and the temperature was taken at the surface of the water.

The true reading can probably have been no higher than 116° or 117°, and it is taken for purposes of calculation at the former figure.

Then $$X = \frac{\frac{10{,}600}{204} - 10}{\frac{1095.5}{204} - 1} = 9.6 \text{ lbs. steam};$$

and the weight of water being 10—9.6=0.4, the percentage of priming was 4, and the water carried over formed $\frac{0.4}{9.6} \times 100 = 4.3$ per cent. of the steam with which it was mingled.

In the third experiment,

$$X = \frac{\frac{10{,}600}{205} - 10}{\frac{1096.5}{205} - 1} = 9.59; \quad W\text{-}x = 0.41;$$

the percentage of priming was 4.1, and of water to steam 4.2 per cent.

The mean percentage of steam above was 93.53.

The mean percentage of priming was 6.47.

19. The total quantity of heat derived from the fuel and taken up by the boilers can now be divided into two portions, and each calculated.

The total weight of steam produced was 73,125 × 93.53 per cent. = 688,393.8.

The total weight of water primed was 73,125 × 6.47 per cent. = 4,731.2.

The mean pressure at which this steam was formed being 71.4 lbs, we find its "total heat" per pound to be 1210.6 thermal units, and the heat communicated to each pound of feed entering at 190°, and evaporated at this pressure 1012.6 units.

The average heat received from the fuel by each pound of water not evaporated was 127 thermal units.

		Units.
Then	68,393.8 × 1,020.6 =	69 802,712.3
and	4,731.2 × 127.0 =	600,862.4
Total heat from fuel		= 70 403,574.7

$$\text{Total heat per cord tan} = \frac{70,403,574.7}{7.7}$$

thermal units = 9,143,321.4 units.

20. The usual standard, as generally accepted by engineers in examples of this kind, is the evaporation of one pound of water at the boiling point, and under atmospheric pressure.

The heat required is the latent heat at 212°, or 966.6 thermal units per pound. We have, therefore—

Equivalent evaporation by one cord of wet spent tan, from 212°, under atmospheric pressure:

$$\frac{9,143,321.4}{966.6} = 9,459.2 \text{ lbs. water.}$$

21. Under these conditions ten pounds of water would be considered a fair evaporation per pound of good coal, and, in this example, therefore, the furnace utilized from each cord of tan the equivalent of 946 pounds of coal.

22. A quantity of the tan was taken from the leach, placed in a "fruit jar," and hermetically sealed. This tan was carefully weighed by Professor Geyer at the Stevens Institute of Technology, was dried by exposure to the air in the study of the writer for one week, and then was again weighed by Mr. Geyer in the presence of the writer. The weights, before and after drying, were respectively 656.8 grams and 268.8 grams. This fuel contained, therefore, 59 per cent. water, and but 41 per cent. woody fiber.

The weight of a cord of this tan, measured in the leach, and then well dried in the open air, would be 2,233.56 pounds, and the equivalent evaporation per pound becomes 424, plus that of the water contained in the fuel—say 1.44, or 5.68 pounds water per pound of combustible.

23. The determination of the temperature of chimney flue, or of the escaping gaseous products of combustion, is thus made.
325 At the first observation fifty pounds of water were heated from 65° to 119° Fahr.—range of 54°—by the cooling of a

mass of iron, weighing 60 pounds, from an unknown temperature to 119° Fahr.

The amount of heat communicated to the water was $50\times54=2{,}700$ thermal units. Each pound of iron, therefore, parted with $\frac{2{,}700}{60}=45$ units of heat.

The specific heat of iron is 0.113; it requires, therefore, the cooling of one pound of iron through nine degrees of temperature to heat a pound of water one degree; the iron, in the case considered, must therefore have lost $45\times9=405°$ F., when cooled to 119° and its original temperature, and that of the escaping gases in the flue must have been $405°+119=524°$ F.

The second observation, in a similar manner, gives the temperature of the chimney flue at 564°.5 Fah.

24. The minute inaccuracy of results thus obtained, which is due to change of the specific heat of water and of metal under varying temperatures, is of no practical importance, and this method is of great value as a last resort, in absence of other good heat-measuring appliances.

THE "CROCKETT FURNACE" AT SPARROWBUSH, N. Y.

25. The second furnace was of the form known as the "Crockett furnace." It has very little to distinguish it from the ordinary forms of furnace.

In this example two furnaces were constructed side by side, each having a grate surface of four by six feet, the total grate area of both being 48 square feet.

The grates were of cast iron, of ordinary form, set so closely that none of the wet fuel could fall through into the ash pit. It was stated that it was not intended that the charred fuel should fall through and burn in the ash pit.

During this trial, however, more or less burning tan was continually falling into the ash pit, and burning there, it undoubtedly assisted, in some degree, in the dessication of the wet fuel by direct radiation of heat and by heating the entering air as it passed over this bed of hot coals.

To this extent the furnace resembled in its actions the Thompson furnace already described.

Above the grates a brick arch was turned, against which the products of combustion impinged, and the heat radiated from the fuel on the grate aided in keeping it at a high temperature.

From the furnace the gases passed directly into the flues beneath the boiler.

26. The tan, wet from the leach, was charged into the furnaces through the doors in the front, as in all usual forms of furnace, and the process of "firing" differed but little from that usual in firing thin fires where coal is used. The fuel was thrown in at intervals of between five and eight minutes, the furnace-man taking care first to

fill all holes in the burning mass, and next covering the whole with a very evenly distributed and very thin layer of fresh fuel. This fresh charge was quickly dried by the heat of the burning fuel over which it was spread and by the intense heat radiated from the hot furnace arch above it, and, taking fire, burned freely. No special effort seemed to be made to obtain "alteration" in working the furnace, but the irregularity with which the fuel burned at different parts of the grate did, perhaps, secure something of this action.

27. The fuel was measured in the leach, as in the previous case, and about a half leach, measuring four and a half cords, was burned during the trial, between 8 o'clock a. m. and 6 o'clock p. m. The actual working time was nine hours, the work being stopped from 12 m. to 1 p. m.

28. The tan-bark burned was hemlock mixed with some oak. It looked like a better material than that used in the other trial. It was more cleanly ground, seemed less "soggy," and had a much better color.

29. The boilers used here were two in number. One was an old-fashioned "Cornish" boiler, 4 feet in diameter and 18 feet long, with one 24-inch flue. The second was 6 feet in diameter, with four 18-inch flues; the total length was 15 feet. The gases from the furnace were led under the boilers, and then, with a double return, through the boiler flue to the chimney.

The total heating surface, reckoned as before, was very closely 700 square feet.

30. The flues were stated to have been so long in use without cleaning that the draft was somewhat impeded by the accumulation of ashes beneath the boilers, and that the rapidity of combustion was somewhat lessened. This trial, like the other, is, therefore, to be taken as representing less than the maximum capacity of the furnaces.

31. The trial was made by a somewhat similar method to that adopted in the one already described. The quality of steam was determined similarly. The water was measured differently. In this case the capacity of the feed pump exceeded several times the requirements of the boiler, and the only absolutely reliable means of determining the quantity of feed seemed to be to measure every pound going to the pump, thus evading the uncertainty attending any attempt to secure regularity in the action of the latter.

32. A barrel was fitted to the suction pipe of the pump, and an employe of the Mechanical Laboratory of the Stevens Institute
329 of Technology was stationed with a hose to fill it with water when it became empty and to keep an account of the number of barrels used, while an employe of the proprietors of the tannery, stationed at the pump, checked the account.

All of the water fed into the boilers during the trial was thus measured, and, at the close of the trial the barrel was taken out, filled on the scales, and the weight of its contents determined.

33. There was no opening into the chimney flue through which

the escaping gases could be reached, and their temperature was not determined. The appearance of steam at the top of the chimney during a considerable part of the time, however, proved the temperature there, at such times, to be approximately 212° F., and it will probably be sufficiently correct to assume that the mean temperature was as low as, or lower than, 450° F.

During the trial some scrap leather and grease was brought from the currying shops and thrown down at the boiler shed. A small quantity of this was used with the spent tan. This may have raised the apparent efficiency of this furnace somewhat, but probably not in any very important degree.

34. The amount of smoke issuing from the chimney of this furnace was considerably greater than was observed at the preceding trial, indicating that the Thompson furnace secured a more perfect combustion than the Crockett. The greater amount of steam seen issuing from the latter indicated a lower temperature of flue also.

35. The results of this trial were the following:

Total number of cords of tan burned	4.5
Total weight of water fed to boilers	28,509 lbs.
Temperature of feed water entering boiler (est.)	160 deg. F.

Temperature of water observed in determining "priming":

	Initial.	Final.	Range.
1st observation	68 deg.	118 deg.	50 deg.
2d observation	70 deg.	118 deg.	48 deg.
3d observation	76 deg.	126 deg.	50 deg.
4th observation	76 deg.	124 deg.	48 deg.
Length of trial			9 hours.

36. Estimating the priming as before, we obtain from the several observations, which were made with the steam pressure, per gauge, 55, 50, 45 and 60 pounds, respectively, $x=9.02$, $x=8.07$, $x=9.12$ and $x=8.55$, and the percentage of priming 9.8, 19.3, 8.8, 14.5 per cent. The mean of all observations gives the average percentage of priming at 13.1 per cent., and indicates that the steam issuing from the boiler carried in suspension 15 per cent. of its own weight of unevaporated water.

37. We determine the total heat from the fuel, thus:

Steam produced, $28,509 \times 0.869 = 24,774.32$ pounds.

Water primed, $28,509 \times 0.131 = 3,734.68$ pounds.

The mean pressure of steam during the trial was 50.44 pounds per square inch, and its temperature 298°. Its total heat at 298° from 0° Fahr. was 1204.8 units per pound. Then we have—

Total heat per pound of steam, $1204.8 - 160 = 1044.8$.

Total heat per pound of water, $298 - 160 = 138$; and

Total heat transferred from fuel to steam, 25,884,209.54 units.

Total heat transferred from fuel to water, 515,385.84 units;

and hence—

Total heat transferred from fuel to feed, 26,399,595.38 units.

Total heat per cord of wet tan, 6,866,576.75 units.

Equivalent evaporation, per cord, water at 212°, 7,103.84 pounds.

Equivalent weight of coal for cord of tan, 710.38 pounds.

38. A sample of the fuel used in this trial was sealed up, as before, and was similarly weighed at the Stevens Institute of Technology, dried in the air one week, and its loss of moisture determined.

This sample contained 55 per cent. of water and 45 per cent. ligneous material. The weight of the tan in the leach was judged to be practically the same as in the preceding trial, and the equivalent evaporation per pound is $\frac{7103.84}{2233.56} = 3.19$, plus the water held by the fuel, say 122, or 4.41 pounds.

CONCLUSIONS.

39. Comparing this result with that found for the Thompson furnace, we find that the former exceeds the Crockett furnace, in economical use of fuel, by the evaporation of $5.68 - 4.41 = 1.27$ pounds of water per pound of combustible, or $1.27 \div 4.41 \times 100 = 28.6$ per cent. of the latter.

Comparing thequantities of heat actually utilized by transfer from the fuel to the boilr, w e obtain, as the measure of the actual comparative efficiencies of the two furnaces, $424 \div 3.19 = 133$—the Thompson excelling the Crockett 33 per cent. A number of unimportant circumstances combine to make the actual difference somewhat greater than the record here indicates; but this result may be taken to represent practically the relative economical standing of the two furnaces.

40. Experiments on dry pine wood, made by Professor Johnson, during his extended and invaluable examination of American coals* for the U. S. Navy Department, furnish a standard of comparison which will be useful here.

330 One cord of well-seasoned yellow pine wood weighed 2689.2 pounds—ten per cent. more than a cord of thoroughly air-dried spent tan bark—and one cubic foot weighed 21 pounds.

Experiments on evaporative power showed, as a mean result, an effect equivalent to the evaporation of 4.69 pounds of water from 212°, under atmospheric pressure, per pound of wood consumed, the temperature of the chimney flue being 315°.2 Fahr., and the wood burning at the rate of 15.87 pounds per square foot of grate per hour, under a boiler having a ratio of heating to grate surface of 26.83 to 1.

41. Comparing this result as a standard with the evaporation obtained in the two wet fuel furnaces, per pound of fuel exclusive of water, we get for the Thompson furnace $5.68 \div 4.69 = 1.21$, and for the Crockett, $4.49 \div 4.69 = 0.94$.

*Report to the Navy Department on American Coals, by Walter R. Johnson, Washington, 1844, pp. 546–550.

The Thompson furnace is thus seen to have given a better result per pound of ligneous combustible when burning wet tan than was obtained in the ordinary steam boiler furnace burning seasoned yellow pine, this superiority reaching 21 per cent.

The Crockett furnace had 94 per cent. of the efficiency of the common wood-burning boiler furnace.

42. The relative efficiency of fuel, comparing wet tan with dry wood by weight, the former containing between 55 and 60 per cent. water, becomes $4.24 \div 4.69 \times 100 = 90.40$ per cent., each fuel being consumed under the most favorable conditions shown above, and equal weight of ligneous fuel being taken for comparison.

A cord of dry yellow pine, as per experiments of Prof. Johnson, evaporated 12618.3 pounds of water. A cord of wet spent tan burned in the Thompson furnace was equivalent to $9459.2 \div 12618.3 = 0.75$ cord of dry wood. One cord of wet spent tan burned in the Crockett furnace was equivalent to $7103.84 \div 12618.3 = 0.56$ cord of dry yellow pine.

43. A cord of dry yellow pine is approximately equal in heating power to 6-10 of a ton of coal, and conversely, the ton of good coal is equal in calorific power to $1\frac{2}{3}$ cords of soft wood.

A pound of dry wood is theoretically capable of evaporating 6.66 pounds of water from and at 212° Fahr. A pound of good anthracite similarly should evaporate $13\frac{1}{2}$ pounds of water. The absolute efficiencies of coal and wood under the conditions already described in the several cases mentioned, are as follows: Coal, 70 per cent.; wood in the Crockett furnace, 66 per cent.; in the ordinary steam boiler furnace, 70 per cent.; and in the Thompson furnace, 85 per cent., reckoning the evaporation of the moisture of the fuel; excluding this moisture the percentages become respectively 70, 48, 70, and 64.

Collating the facts given above, and placing them in tabular form as follows, the most important data are obtainable readily:

Result of trials of furnaces burning wet spent tan bark, August, 1874.

Name.	Fuel.	Percentage.		Total Weights, in Pounds.					Percentage.		British thermal units per cord tan.	Apparent Evaporation.			
		Water.	Combustible.	Fuel.	Combustible.	Feed.	Steam.	Priming.	Priming to feed.	Priming to steam.		Per cord fuel.	Per lb. combus.	Per sq. ft. grate per hour.	Per sq. ft. heat surf. per hour.
Thompson...	Tan.....	59	41	14,944.98	17,198.41	73,125	68,393.80	4,731.20	6.47	6.92	9,143,321.04	9,596.75	4.25	23.7	2.81
Crockett.....	Tan.....	55	45	22,336.00	10,051.20	28,509	24,774.32	3,734.68	13.10	15.00	6,866,576.75	6,335.33	2.83	65.9	4.52
Ordinary.....	Wood...	20	80	.....	2,360.50	.....	.....	.....	.....	.....	.....	10,891.26	4.05		
Ordinary.....	Coal.....	.....	90												

Name.	Actual Evap'n.		Equiv. evap. per 212 deg. F. per lb., including water in fuel.	Equiv. evap. from 212 deg. F. per lb. combustion.	Relative efficiency, Crockett=1.	Relative efficiency, wood=1.	Relative efficiency, incl'g in ace't water in fuel, Crockett=1.	Relative efficiency, incl'g water in fuel, wood=1.	Absolute efficiency, Theoretical calorific power=1.	Absolute efficiency, incl'g water in the fuel.
	Per lb. fuel.	Per lb. combust.								
Thompson	1.3	3.98	5.68	4.24	1.33	0.90	1.29	1.21	0.64	0.85
Crockett.....	.....	2.46	4.41	3.19	1.00	0.68	1.00	0.94	0.48	0.66
Ordinary	.....	.....	4.60	4.69	1.47	1.00	1.06	1.00	0.70	0.70
Ordinary	.....	.....	10.00	10.00	3.13	2.13	2.27	2.13	0.70	0.70

Mechanical Laboratory, Department of Engineering, Stevens' Institute of Technology, Hoboken, N. J., August, 1874.

331 Q. Which requires the most labor, feeding in of this wet tan furnace, in front or on the top?

A. All things being equal, it would require more labor to feed the furnace from the front.

Q. Look at Exhibit Dosch 1, 2, and 3, attached to the affidavit of Daniel Dosch, made in this case March 8th, 1873, and state how far this exhibit resembles the furnaces which you saw at Laporte and Thorndale?

(Objected to as immaterial and irrelevant.)

A. These drawings seem to represent the furnaces which I saw at Laporte and Thorndale, except that those furnaces, as I saw them, had three holes closed up, only one being in use—a part of the grate surface being blocked off—covered up with bark.

Cross examination:

Q. State what you mean by blocking off a portion of the grate surface?

A. Covering up the grates with any incombustible material in order to prevent the ingress of air at the part of the grates which it is not intended to use, or which, for any reason, cannot be used; in this case it was done in order that the tan might be fed more nearly in the centre of that part of the grate which was effective.

Q. Do you understand the furnaces represented in the Dosch Exhibit to have allowed of and to have been used for alternate feeding?

A. I know nothing of their use; they would have allowed of alternate feeding.

Q. Would the furnaces at Laporte and Thorndale with but one feed hole have allowed alternate feeding?

A. I should think not.

Q. Do you not understand the furnaces represented in Dosch to permit the products of combustion from the several fire chambers to pass into one mixing chamber?

A. Yes.

Q. Do you not understand that the Exhibit Dosch allows the products from the mixing chamber to pass under the boilers in common?

A. That is my understanding.

Q. Do you not know that there is in the furnaces at Thorndale and Laporte a separate partition wall under the boilers in such form and effect that what proceeds from one fire chamber is kept separate from what proceeds from another, until it reaches the chimney?

A. I was informed that that was the arrangement.

Q. Then state on what principles of science, and upon what analogy of construction you gave your answer that the drawings of the Dosch Exhibit represent the furnaces which you saw at Laporte and Thorndale?

A. In my answer I referred to the furnaces proper, and not to their flues or mixing chambers; I mean the furnace proper.

Q. Is not alternate feeding, in the sense of Thompson's invention, a matter for which his furnace provides?

A. That is one of the features of Thompson's furnace.

Q. Now will you explain every particular in which a furnace, in the sense you define it, described by Dosch, resembles the furnaces at Laporte and Thorndale?

A. The furnace described by Dosch and the furnace which I found at Thorndale seem to have been originally indentical.

Q. Give them as they are?

A. The furnace proper in Thorndale is the furnace shown by Dosch, except that three of the feed holes have been closed up, leaving but one in use.

Q. Do you understand the Dosch furnace to contemplate what you call an incineration chamber?

A. I do not.

Q. Do you understand that there is any fire in the ash pits of the Laporte and Thorndale furnaces?

A. I do not.

Q. Is it true that a person walked in all around the ash pits of the Laporte and Thorndale furnaces without danger of being burned?

A. I went into one myself.

Q. What do you mean in your answer to-day as to the labor of feeding, by the phrase "other things being equal"?

A. I mean that the labor of feeding consists usually, partly in the transportation of the fuel from the fuel pile to the furnaces, and partly in that of throwing the fuel upon the fire; conditions sometimes arise which may make a serious difference in the amount of work required in the first part; that being equal, the labor of throwing the fuel into the hole, as in the top of the Thompson furnace, is far less than that of throwing it through the furnace door in front, uniformally over the fire.

Q. Have you ever seen any of these tan-burning furnaces before this expedition of yours in August last?

A. Not recently.

Q. When did you see them?

A. I remember seeing a tan-burning furnace in Providence, R. I., some years ago; I am not certain that I have seen others.

Q. When did you see the one in Providence, how long did you look at it, and why did you see it at all?

A. I went to see it as a matter of professional interest, but I cannot give the date.

Q. Well, about?

A. It was probably a dozen years ago; I do not remember how long I was present.

Q. Do you claim that a furnace like those at Laporte and Thorndale, which allowed no alternate feeding, which had no fire in the ash pit, which had no separate mixing chamber, which allowed no communication for the products of combustion to one fire chamber from those from another, is a Thompson furnace; if you do, state

what part of its construction, in your opinion, makes it a Thompson furnace?

A. I have not been asked before to consider that question, and have made no such claim.

Q. Will you answer it now?

332 A. I should be unwilling to give an opinion without more deliberation than I can give to it now.

Q. Will you state what, in your judgment, is essential to constitute a Thompson furnace, if you have any opinion upon the subject?

A. I have not been called upon to form an opinion upon that subject, but am willing to present my present impressions, if these are of any value.

Q. Are the views you have on the subject, then, anything more than impressions?

A. In some respects they are, probably, well founded.

Q. State every respect in which you regard them as well founded.

A. My opinions, such as they are, have been formed after reading over Thompson's claim and inspecting furnaces built under this claim, and, so far as my opinions are based on knowledge so acquired, I have no doubt that they are well founded.

Question repeated, it being claimed that the answer is not responsive.

(Objected to as being already answered.)

Q. Then, when in various places in your direct examination you have called a thing a Thompson patent, or that it resembled a Thompson patent, or that it operated or had elements like a Thompson patent, is the standard to which you applied made up of a compound of these opinions and impressions as to what is really essential to a Thompson patent?

A. No, sir.

Q. Then state what one or more particulars of construction, as being essential to a Thompson patent, you had in your mind and used as a standard when you stated or hinted, in your direct examination, that some particular furnace was a Thompson furnace?

(Objected to; objection overruled.)

A. I believe that, in my direct examination, I have given no hints, but made certain statements which I considered were fully sustained by a comparison of the reading of Thompson's patent with the actual case as found. In some instances a furnace may be constructed in such a manner that those resemblances, or such differences as may exist, may become very slight. When these differences or those resemblances have appeared to me so slight as to become debatable, I have endeavored to avoid reference to them. The essentials of a Thompson furnace, as I understand them, then, after reading Thompson's claim, and after inspecting Thompson's furnaces, are: First, such a construction as shall allow for alternate feeding; second, a construction as shall permit a mingling of the gases arising from the fuel during distillation with those arising from the combustion of the charred fuel; third, such a construction as shall permit the dried and

partially consumed fuel to fall from the chamber in which it was dried and partially consumed into a second chamber, in which the combustion becomes complete.

Q. Now, sir, according to that rule, do you regard the furnaces at Laporte and Thorndale as Thompson furnaces?

A. This question cannot be categorically answered by me. There are points in regard to the construction and operation here that I should wish to consider very carefully before giving my reply. I will say, however, that the differences between those furnaces and a Thompson furnace properly constructed are very marked, and such as to bring them fully within the debatable ground to which I have referred.

Q. State any one element possessed by the Thorndale or Laporte furnace which you can imagine to be an essential part of a Thompson furnace, or which is not contained in either furnace at Sparrowbush or at Crockett.

A. I should be unwilling to name any one element.

Q. Tell us, then, how the question whether the structure of a furnace can at the same moment come within a patent as so dubious as to be on the debatable ground you refer to, and at the same time so clear that you cannot imagine it to come within the patent?

A. The question asked seems to me to assume that I have made a claim which I have endeavored carefully to avoid making, and which I have not been called upon to consider.

Question repeated.

(Repetition of the question objected to; also objected to on the ground that it assumes a statement made by the witness which he has not made; objection overruled; question allowed.)

A. I have not been employed to consider the question of infringement, and am unwilling to give any testimony without more consideration than I have been able to give to it, bearing upon the question. My duty in this case has been simply to ascertain, as well as I might, precisely what were Thompson's claims, to determine the efficiency of the Thompson furnace, and to compare the results there obtained with those obtained at a similar trial of a furnace which has been put in evidence as being entirely free from Thompson's claim.

Q. Then shall we understand that, after all the investigations you have made with the Thorndale furnace, you cannot say whether it infringes the patent or not?

A. No, sir, you are not to have any such understanding.

Q. What are we to understand?

A. You are to understand that I have not given that part of the subject the consideration which I would desire to give it before considering myself prepared to give an opinion.

333 Q. You were employed by Mr. Black to make those scientific investigations?

A. I was.

Q. Will you tell me if the printed copy which you have handed

in of your statement is substantially correct, as near as you can make it out?

A. It is substantially correct; the only important error that I can detect being copied by the printer from a clerical error in the manuscript. In the tabular statement at the end the absolute efficiency, including the weights of fuel, is given for the Thompson furnace at 58 per cent., instead of 85-100, as correctly stated in paragraph 43. In the same table, at the top, read, instead of "total weights per pound," "total weights in pounds."

Q. Do you mean by the words "per square foot heating surface" per hour, at the top of last column, the same as "per square foot of boiler surface"?

A. It is the same thing.

Q. That paper is a lecture to your class, is it not?

A. It is an abstract of a lecture to my class.

Q. Do you mean to be understood as swearing to the truth of all the statements there, so far as you, as a scientific man, can ascertain them to be true?

A. I believe them to be true.

(Counsel for defendant states that he has only had an opportunity to examine this paper since the examination, at the close of which it was handed in, and now objects to it because it purports to be a comparison between two furnaces, neither of which is involved in the case, and because there is no proof of probability that the furnace at Laporte, Thorndale, or Albion would have given similar results, or were like the one at Binghamton, and because no notice was given to us of the examination, though we had often requested opportunity to be present at any examination that might take place. Objection overruled and exception taken.

Counsel for defendant also objects to the declaration at the close of the seventh paragraph, where he (witness) states what the engineer estimated could be done if he had a better pump. Objection overruled and exception taken.

Counsel for defendant also objects to all that is contained in the tenth paragraph as being matter personal to the witness, and entirely irrelevant to the case. The objection was overruled as not having been taken in time; exception taken.

Counsel for defendant also objects to all that is contained in the fourth paragraph, and to the statements based upon it, on the ground that the manner of conducting the measurement therein contained is neither scientific in its character, nor is it the best method which might be improvised by a non-scientific person. Objection overruled as not taken in time; exception taken.

Counsel for defendant objects also to all parts of the statement based on information obtained from other persons at the time of conducting the measurement. Objection overruled as not taken in time, and exception taken.

Counsel for defendant also object to the parts in the 41st and 42d paragraph, and elsewhere in the statement, where a comparison is

made between the wet tan and dry fuel, and between these furnaces as dry fuel burners and wet fuel burners, for the reason that no such issue is in the case, and the matter relates only to other possible litigation. Objection overruled as not taken in time; exception taken.)

Q. Who accompanied you on this tour of examining these furnaces, and who aided you in the tests?

A. I was accompanied on my first tour of examination by counsel for the plaintiff, and by Mr. Plumb, an expert witness, as far as Great Bend; during the remainder of the journey I was accompanied by counsel; I went alone, when I found time, to make the tests, and obtained no other assistance than that of people whom I found at those places, and at Sparrowbush my own assistant.

Q. How much time did you occupy in making the eight examinations of the different furnaces to which you have referred?

A. One week.

Q. Before you went had you read Mr. Plumb's and Professor Silliman's testimony as to the Sparrowbush furnace—its action?

A. I had not.

Q. Not read their testimony in this case at all?

A. Oh, no; I had no time.

Q. Did you come to the conclusion stated by Professor Silliman, that Sparrowbush burned a large proportion of dry wood and made but little heat?

A. I did not form any conclusion upon the subject.

Q. Did you state, while you were at Sparrowbush, in the presence of any person there, this, or anything equivalent to it, "that Sparrowbush furnace was the hardest nut that Mr. Black had got to crack"?

A. I do not remember making any such statement.

Q. Will you swear that you did not at any time?

A. I will not swear that I did not, but I feel very confident that I did not.

Q. Did you enter upon either of those tests with the idea that water in dry fuel would increase its capacity to give off heat?

A. I did not.

Q. Did you agree with the idea contained in Thompson's patent, that wet fuel is more efficient than the same fuel dried?

A. I do not.

Q. Did anything in your examination there lead you to conclude that if the tan burned in the Binghamton furnace had been wetter than it was, or that, in consequence of its having a consider-
334 able percentage of water in it, it was more efficient or valuable as fuel than dry tan?

A. No.

Q. Are you acquainted with a work entitled "Practical Treatise on Heat," by Thomas Box?

A. I have the book in my library, and examined it when I first obtained it; it is a work of respectable authority.

Q. You are now asked your opinion of the following passage

from the 36th paragraph of that treatise, namely: "When a combustible contains water with which it is more or less saturated the effect is twofold; say we take wood in its ordinary state, containing 20 per cent of water, the real combustible matter is reduced 80 per cent. of the amount contained in the same weight of wood perfectly dry, and, of necessity, the caloritic power is reduced in the same proportion; the second effect is that part of the heat in the residue is consumed uselessly in the evaporating water;" and your attention is called to the 37th section and 37th page, as follows: "The experiments of Rumford have shown that the heating power of wood varies only with its dryness." Now, are those statements reliable; and if so, in what respect are they reliable, and does the rule of Rumford apply to the bark of wood as well as to wood?

A. The statements are, I think, substantially correct, and apply to bark.

Q. I suppose your faith in those principles accounts, does it not, for the statements contained in the 8th paragraph of your lecture, in which you speak about allowing the wet tan to drain a few hours before you burned it?

A. That statement has no reference to principles; it is simply a statement of fact.

Q. Your attention is called to the 267th and 268th pages of the complainants' proof, where Professor Silliman says: "That while it is an accepted principle of the science of heat that the amount of useful effect in any quantity of mixed fuel is just that which is due to caloritic fuel, the simple carbon it contains;" and then to page 294, where the professor corrects his statement, and talks about hydrogen and water; and then to the 582d page, folios 1,738 and 1,739, where Mr. Plumb gives his views on the subject. Now state which variation of the professor's opinion you agree with, and whether you agree with Mr. Plumb or not; and if you think that any amount of hydrogen, according to their views, can be got by pouring water on fuel, or burning wet fuel, what amount you can get, and what use could you make of it?

A. Professor Silliman's opinion is sustained by chemists who are considered authorities on the matter, and I should feel some hesitation in giving my opinion against theirs, could it have weight as that of a chemical expert. My own opinion is that there is no gain by the use of wet in preference to dry fuel.

Q. Now, sir, refer by name to any respectable writer or authority on chemistry, beyond the professor thus divided against himself, who sustains the views of Mr. Plumb and Mr. Silliman referred to?

A. These gentlemen have presented the best evidence, if I may judge by my own cursory examination, recently made, of their testimony, and the only other evidence I have obtained has been by conversation with chemists, some of whom have seemed to consider it a question whether water in fuel might not be made to add to the amount of heat obtainable in the mass.

Q. Name these chemists and their residences—their official position.

A. I would not like to mention the name of any one, as my impression has been formed (and it is very vague) simply by conversation.

Q. For what reason can you, as a scientific man, refuse to give, in your testimony, the names of scientific authorities, when you have thrown the weight of their opinion against the defendants in this case?

A. The question assumes that I have thrown the weight of such opinion against the defendants, while I have explicitly stated that my own opinion is formed from such evidence as has presented itself to me, to the contrary.

Q. If the opinion that the addition of water to fuel, or the existence of water in fuel, adds to it spower to produce heat, is not so unscientific, why not give the authority—the names of those who hold the opinion?

A. My previous answer applies to this question.

Q. Do you know of a statement in the English tongue, or in any tongue, that supports the opinion that wet fuel is better than dry? If so, where is it?

A. I do not call to mind any such statement, except such as I find in the printed evidence in this case.

Q. Your attention is called to the 33d page, 26th section, of "Box on Heat," where this language occurs: "When a combustible contains hydrogen and oxygen, in the proportion required to form water, they combine during the process of combustion, but give out no useful heat." Is that sound philosophy?

A. I believe the statement as there made to be inaccurate; in combustibles containing the gases mentioned in the proportion required to form water, these gases usually, if not invariably, are already in combination with the other elements which, with them, make up the compound, and therefore combustion simply liberates them, still combined, and they give out no heat; the result, however, is the same.

A. You agree there is no heat gained?

A. Yes.

335 Q. In your direct examination you speak about the efficiency of the furnace in the intermixture of products of combustion with those of distillation; state what you mean by distillation and by its products, and by combustion and its products.

A. The products of distillation in this case are combustible gases and the vapor of water, and the products of combustion are the result of a union of the carbon in the fuel, and of a combination of the hydrogen contained in these combustible gases with oxygen.

Q. What combustible gases did you get out of the distillation?

A. Hydrocarbons.

Q. Can you burn wet tan without producing that distillation in any ordinary furnace?

A. I should think not.

Q. When an ordinary stick of green wood is put in a fire-place, does not the distillation as well as the combustion take place before the stick is burned?

A. It does.

Q. How could you get any more of the elements of those combustible gases out of it, if, instead of laying the stick somewhat burned on ordinary hand irons, you were to lay it on the grates of Thompson's furnace?

A. No more could be got out.

Q. You were referred to the first and second columns of the table attached to your paper, and asked why the columns were not filled out with figures.

A. Because my only object in putting in what figures are entered there was to give a standard by which to compare the results obtained in the two furnaces tested.

Q. Then why did you put the figures in corresponding places in other columns?

A. As a matter both of interest and importance; these figures are those obtained during the trials, and they are all entered here, that all results of importance so obtained may be seen at a glance.

Q. If you did not burn any coal or dry wood, how did you get the figures during the test about coal and dry wood?

A. That is explained in the text preceding the table, with, I believe, the single exception that I neglected to state that Watts was my authority for the theoretical efficiency of ligneous matter.

Q. What is the significance of the figures 1 21-100 as compared with 100 in the third lower column from the right-hand side of the table?

A. In that column the efficiency of the ordinary wood-burning furnace is taken as a standard, and the figures indicate that Thompson's furnace evaporates 21 per cent. more of water per pound in its fuel than does the ordinary wood-burning furnace.

Q. Do you attribute that to wet fuel being more efficient than dry fuel, or to some merit in the furnace you tested above the furnace in which dry wood was tested?

A. I attribute the difference to the superior construction of the Thompson furnace.

Q. In estimating the heating power of wood, what did you estimate to be the units of heat per pound of fuel?

A. The figures which I obtained for that quantity were obtained from Watts' Dictionary, and are equivalent to an evaporation of 6,660 lbs. of water from it at 212 degrees Fahr.

Q. Box is referred to at page 38 as follows: "The heating power of wood in its ordinary state of dryness may be taken at about 3,500 units per pound of fuel." Does your mode of estimating agree with that, or are you prepared to say it is not true?

A. The figures, as given by Box, represent, as I understand it, the quantity of heat which may be obtained in an ordinary furnace per

pound of fuel, and the figures which I gave was the value of the fuel which might be obtained could we burn it in a perfect furnace; those figures are taken as a standard; the figures given by Box are lower than have actually been obtained by practice.

Q. When you went to test the Binghamton furnace did you let them know you were going at the time appointed?

A. I wrote to Mr. Weed a day or two before, saying that I would be there at the date given; that only applies to the Binghamton furnace.

Q. Are you quite sure some portion of this heat you felt there was not due to the August sun?

A. The same August sun shone at both trials, and I am very sure that at Binghamton the high temperature observed was due to the furnace.

Q. Is not the room inclosed at Binghamton much more than at Sparrowbush?

A. The fire room at Binghamton opened into the air at both ends, so that the air could pass freely across the top of the furnace; at Sparrowbush one end of the fire room was entirely open, but there was no such opportunity for the air to pass through it; at Binghamton I stood upon the top of the furnace, but found it extremely uncomfortable; at Sparrowbush I stood upon the top of the furnace without discomfort.

Q. When you arrived there at Binghamton were the furnaces out, or were they going, hot?

A. They were going.

Q. What account did you take of the fuel in the furnace at Binghamton when you went there?

A. My trial began and ended with the furnace filled, and as nearly as possible in the same condition; no account, therefore, needed to be taken of the fuel in the furnace at either end of the trial.

Q. When you speak of the mingling which took place in the Binghamton furnace in the rear end, how do you know that such mingling took place?

A. I do not speak of the gases as mingling at the rear end of the boilers; this mixture took place at the rear end of the furnace, and the mingled gases passed as described.

336 Q. Does not the blowing off of steam depend, in part, upon the ease with which the machinery moves without external resistance, and upon the external resistance it has to overcome as well as upon the pressure of steam?

A. When steam blows off by the safety valve, it is simply because the pressure has risen above the limit at which the safety valve is fixed.

Q. To whom, if to anybody, did you give notice of the time that you would make the experiment at Sparrowbush?

A. I sent my assistant several days before I went there myself, with a note to Swazey, Cooper & Co., asking their permission to

make the trial, and the aid of their assistants, so far as it might be absolutely needed.

Q. Who did assist you there?

A. I was assisted there by Mr. Stedworthy and my own assistant.

Q. Did you give any notice to the defendants in this case of either of those examinations?

A. I did not.

Q. State the hour of your arrival at and departure from the Stevens furnace?

A. I made no record of the time of my arrival or departure.

Q. About how many minutes did you stay there?

A. I was at the furnace twice. As near as I now remember it must have probably been half an hour at the first visit, and somewhat less time at the second.

Q. Do you not know that there is but furnace here?

A. Yes.

Q. Do you know that there was alternate feeding, and what did it consist of?

A. I saw feeding done alternately through different doors of the furnace.

Q. Do you think this furnace to be a Thompson furnace?

A. I have already stated more than once that I have avoided expressing an opinion on the question of infringement, on the ground that the matter is of too great importance to justify my giving such an opinion without ample consideration.

(Question repeated, and defendant's counsel insists on having an opinion, it being apparent that the witness deliberately avoids it. Overruled and exception taken.)

Q. As you understand Thompson's patent, does it cover any boilers, or in any form relate to the kind of boilers that may be used?

A. I do not understand that it does.

Q. You say in your direct examination, "I conclude that one of the most important of those provisions was that called an incineration chamber." Do you think it more important than a mixing chamber in a Thompson furnace?

A. I have no means of determining their exact relative importance.

Q. For what reason did you select this Binghamton furnace rather than any of those being claimed as Thompson's furnaces?

A. Because it was a furnace in regard to which I could not conceive that any question as to its being a Thompson furnace could arise, and for the reason that I was told and believed that it had been constructed carefully from Thompson's plans.

Q. About when was it constructed?

A. I have no memorandum of the date

Q. State as nearly as you can.

A. I would not like to make an indefinite or uncertain statement.

Q. About what was the relative power of the engines there compared to the engines at Sparrowbush?

A. That I did not determine.

Q. State as nearly as you can.

A. I should have rated the larger Sparrowbush engine at 35-horse power, and that at Binghamton not far from 100; the Sparrowbush engine is an old-fashioned, slow-running engine; that at Binghamton is one of more modern design, with a much higher speed of piston.

Q. Now, sir, which of those engines was the more economical or efficient in its application and use of steam?

A. That could only be determined by experiment.

Q. Do you assume that they were equal in that respect, in your tests?

A. My tests did not involve any supposition in regard to the use of steam.

Q. Then, if I understand you, your tests are based on data which are independent of the efficiency of those engines, or of their economical, efficient or wasteful use of steam as compared with each other?

A. Entirely so.

Q. Then what is the significance or purport of your answer, as bearing upon tests, to the question, Which requires the most steam, the works at Weed's or the works at Sparrowbush?

A. That opinion was formed after an examination of both places, and the tests made were made to determine how far that opinion was correct, as I did not feel sufficiently confident in that opinion, unsupported by actual experiment, to offer it in evidence.

Q. Were you not aware that the works propelled by the engine at Sparrowbush would grind much more bark and tan than those at Binghamton?

A. The evidence that I was able to collect led me to believe that the Binghamton tannery required approximately the same amount of labor, but that they used considerably more steam in tanning.

Q. Does not the blowing off of steam in any given case depend upon the amount of steam worked through the engines as well as the amount of steam made?

A. It does depend upon both circumstances.

Q. Do you know whether the exhaust steam at Sparrow-
337 bush went into the chimney?

A. I did not trace the course of the exhaust steam myself; a portion, and I should judge that all, passed into the heating apparatus for heating the water in the leaches, the excess being discharged through a pipe at the top of the chimney.

Q. Did you personally examine to see how much went into the heating apparatus?

A. I did not.

Q. What you know about it, then, is from information derived from others?

A. No, sir.

Q. How did you learn it?

A. I saw it issuing from the pipe at the top of the building.

Q. Is that all you know about it of your own knowledge?

A. That is all I know about it of my own knowledge.

Q. Will you state the height and character of this chimney at Sparrowbush, both at the top and bottom, as near as you can?

A. The height was about 70 feet; the chimney was square, as near as I recollect: about five feet square at the bottom, tapering slightly toward the top, but what inclination I cannot give.

Q. How many separate times did you look at the top of the chimney during your experiment, and how near to the foot of the chimney did you stand?

A. I looked at it a great many times; I did not count the number; I stood at the foot of the chimney, within two or three feet of it, and at various other distances up to 100 feet, and in one case a half a mile.

Q. When a steamer on her passage blows off steam, and you can see that steam is in the air, does that not show that the steam has fallen to about 212°?

A. It does.

Q. And perfect steam is invisible, is it not?

A. That is true.

Q. Why did you not make the two experiments of about equal length, and which did you make first?

A. I made the experiments of as nearly equal length as I could without the liability of detracting from the accuracy of the result; I made the experiment at Binghamton first.

Q Would there have been an inaccuracy if you made them of equal length?

A. I measured in each case the quantity of fuel used in the leach, taking a full leach at Binghamton and half a leach at Sparrowbush, taking those quantities because I could measure them with probably equal accuracy, and judging in commencing the tests they would be used in approximately equal times.

Q. You assume, then, that the Binghamton furnace would burn a whole leach, and in the case of Sparrowbush half a leach?

A. That was the assumption.

Q. Did you take from a full leach at Sparrowbush?

A. Not from a full leach.

Q. Well, nearly full?

A. Half full.

Q. Was it just half full as you found it?

A. It was just half full, and had been prepared by leveling down carefully to half the depth of a full leach, under the direction of the proprietors.

Q. Can there be, in your judgment, a Thompson furnace without a mixing chamber?

A. It being understood, as previously stated, that this part of the question has not been as carefully considered—

(Answer objected to by Mr. Eaton, and the master is asked to rule that the witness shall state his opinion directly.)

(Witness continues) by me as it would have been had I known that it was to be considered in my examination, I will say that I think a Thompson furnace can be made without a mixing chamber.

Q. Do you think that a mixing chamber, then, is no part of Thompson's invention?

A. I think a mixing chamber is covered by Thompson's claim.

Question repeated, because the witness does not answer that in his opinion it is part of the invention.

A. I think a mixing chamber is part of Thompson's invention.

Q. Look at "Exhibit No. 1, June 30th," referred to in your direct examination, and state, does it not show a flue or passage from the fire chamber to lead under the boiler to the rear end of the same, but constantly diminishing in depth from the bottom of the boiler to the bottom of the flue?

A. I do find such a flue in the drawing.

Q. If any mixing chamber is shown in that exhibit, will you mark in red pencil where it begins and where it ends?

A. The space from the rear end of the grate to the rear end of the brick work forming the arch of the furnace, and partially covering the flue, is marked by me in red, "A B," and seems to me a substantial equivalent for a mixing chamber; and the space from this latter red mark to the rear end of the boiler forms the chamber in which those gases may mingle and combine, and which is covered by the first claim of the reissued patent of 1857.

Q. What do you assume to be the amount of rise in the lower surface of this flue at the point "B"?

Q. I should judge it appears about three inches.

Q. Now, sir, what is the distance from "A" to "B"?

A. It measures three feet.

Q. Now, if the line in the bottom of the flue had continued on in the same direction from "B" to "A" that it is from the rear end of the furnace to "B," would there have been any mixing chamber, in your opinion?

A. In my opinion there would have been a substantial equivalent for a mixing chamber.

Q. According to the views you have expressed of a mixing chamber, would there have been one in the plan before you if the top of the flue had been the same distance from the bottom of the
338 flue as the whole length from the rear end of the boiler to the fire arch?

A. In my opinion there would have been an equivalent for a mixing chamber.

Q. Would there be a mixing chamber if the flue had been twice

as broad, or if it had been only half as broad at the fire chamber as it is at the rear end, the whole bottom line in both cases passing at the same angle within the boiler?

A. I think it would be.

Q. Does not, then, your opinion come to this: That there can be no flue with straight lines to its side leading from the fire chamber to the rear end of the boiler without the end toward the boiler being a mixing chamber within Thompson's patent?

A. The first claim of the reissued patent of 1857, strictly and literally interpreted, covers every such case, "said flue or fire chamber intervening between the fire chamber and the object to be heated or the stack."

Q. Question repeated, because the witness has not given his opinion.

(Question objected to as having been already answered.)

Q. Have you adopted that interpretation of the claim in the patent?

A. I have, certainly.

Q. Can you now state whether, with your opinion and interpretation of the claim, and your definition of a mixing chamber, there is not a mixing chamber in the furnace you tested at Sparrowbush, within the meaning of Thompson's patent?

A. It is my opinion that that claim covers the flue issuing from Sparrowbush furnace.

Q. In your opinion is the Sparrowbush furnace you examined, and the Crockett furnace in its original structure, an infringement or not of Thompson's patent; and if not, why not, according to the construction you have adopted?

A. The Sparrowbush furnace, as I saw it in operation at the time of the tests of which I have given an account, was a Thompson furnace, in so far as this flue leading under the boiler allows of a mixing and mingling of the gases in the sense used in the first claim of Thompson's reissued patent of 1857, and was an infringement of the first and the second claim, if not the third, of the other patent, Dec. 15th, 1857.

Q. State distinctly whether, in your opinion, according to the interpretation you have given of the patent, the Sparrowbush furnace was or was not a violation of that patent.

A. I consider the Sparrowbush furnace to have been a violation of that patent.

Q. Is it not a more clear violation of that patent than "Exhibit 1" of June 30th; and if not, why not?

A. "Exhibit No. 1," June 30th, 1874, gives no means of determining whether the furnace there shown infringes the patent of Dec. 15th, 1857; I therefore cannot give a definite answer.

Q. Is not this Sparrowbush furnace more clearly an infringement than the one shown in said exhibit, so far as depends on a mixing chamber?

A. I am not able to say which I consider the more evident infringement.

Q. Was there any dry fuel burnt at Sparrowbush during the experiments; if so, state exactly what it was and the amount?

A. There was none burnt to my knowledge, with the exception of a small amount of greasy material referred to in my report of that trial.

Q. State the amount of it in pounds as near as you can, and how it happened to be used.

A. There was so little that I don't think it would appreciably affect the result of the trial, and I did not consider it worth the trouble of weighing or measuring it; it seemed to be waste material brought there incidentally, and without any apparent intention of using it for the purpose of affecting the test.

Q. Do you remain of the opinion that Mr. Du Faur's manner of measuring the water in his experiment might be unreliable, as suggested in your direct examination?

A. Mr. Du Faur has since explained to me in detail his method; it is identical with mine.

Q. You are referred to the figures at the bottom of your table, on the fourth line from the right side, commencing 129 and terminating 227, and state whether these tend to show, or are intended to show, that the furnace of Binghamton showed wet fuel to be more efficient or economical than dry fuel; and if not, how you account for the figures 129 as compared with 106, and give a like explanation in regard to the next column of figures, commencing 121 and terminating 213.

A. The column first referred to is intended to show the relative efficiency of the Binghamton furnace burning wet fuel, the Crockett furnace burning wet fuel, the ordinary steam-boiler furnace burning dry wood, and the ordinary steam-boiler furnace burning anthracite coal as determined by the quantity of combustible material in each case, and I refer to the Crockett furnace, so called, or the Sparrowbush furnace, as a standard; it indicates that the fuel contained in the wet mass introduced into the Binghamton furnace is more economically used than that contained in the wet mass introduced into the Crockett or Sparrowbush furnace, or even than the dry fuel used in the ordinary steam-boiler furnace; it is not intended to show that wet fuel *per se* is more economical than dry.

Q. Does not your manner of answering the question assume
339 that the two kinds of fuel, wet and dry, are burnt in furnaces not equally good?

A. It does.

Q. Does that prove, then, anything more than that wet fuel, in a good furnace for burning it, may be better and may be more economical and efficient than dry fuel in a bad furnace for burning it?

A. It proves slightly more than that; it shows that wet fuel burnt in a furnace of exceptionally high efficiency may be better than dry fuel burnt in a furnace of ordinarily good construction.

Q. In those experiments you have not included the water in the fuel as a part of the evaporation?

A. In the first column it is included; in the adjacent column it is not.

Q. Then does not that tend to show that it is a more economical way to make steam, to make some part of it in the fire chamber than to make it all in the boiler?

A. It does not.

Q. Does not your experiment in testing the Binghamton furnace on the basis of the amount of steam made from the use of a given amount of fuel bring into the test the merits of the boiler as well as of the furnace?

A. To a certain extent it invariably does.

Q. If your boilers had been of that inferior quality in use at the time of Watt's great invention, and since superseded, would you not have got an inferior result as to the practical efficiency, dependent upon the inferiority of the boiler or the inferiority of its surface, in proportion to the contents or to the amount of fuel burnt per hour?

A. An inferior boiler would have produced a lower result.

Q. Would it not, upon the recognized principles of science applicable to the subject, would it not have been substantially proportioned upon the elements referred to in the question?

A. I do not see the bearing of this last question.

Q. What would that inferior result be proportioned upon?

A. It would bear some relation to the ratio of area of heating surface to the area of grate.

Q. Do you mean by area of heating surface the same thing as area of boiler surface?

A. The area of heating surface is a correct expression, meaning the area of surface in the boiler exposed to heat. Area of boiler surface is a less correct expression for the same quantity.

Q. Have not the changes in the structure of boilers since Watt's time considerably increased the area of heating surface to grate surface?

A. In general practice they have.

Q. Is not a tubular boiler superior to the flue boiler it has so generally superseded in presenting a greater amount of boiler surface exposed to heat?

A. It is.

Q. Is not the ratio of grate surface to grate surface in the two furnaces you tested such that the Binghamton furnace is five times greater than the Sparrowbush?

A. It is 4 8-10 times as great.

Q. And the boiler surface is about three times greater at Binghamton?

A. The boiler surface is nearly three times as great.

Q. Now, is not the area of boiler surface exposed to heat at Binghamton greater in proportion to the whole boiler surface than at Sparrowbush; if not, state how they differ as to that?

A. That is an estimate which I have not made.

Q. Are not the elements of your estimates, and your deductions

from them, such as to involve the practical efficiency or good results of the boilers, respectively, Sparrowbush and Binghamton?

A. Yes.

Q. Now, state the manner in which the heat enters the flues, and what course it takes to get to the chimney in the Sparrowbush furnace?

A. The fire passes through the flues beneath the boiler, the heat reaching all its lower surface, and returns through the flues, then passes to the chimney.

Q. How many flues for each boiler for the return to the chimney?

A. There are four flues in one boiler, and one in the other.

Q. Which of those two boilers should you consider the most economical for absorbing the larger amount of heat, the four flue or the single flue?

A. The four-flue boiler.

Q. Those boilers were known as Cornish boilers, were they not?

A. No, sir; one was a Cornish boiler, the other is called a plain flue boiler; that with the one flue is called a Cornish boiler.

Q. Now, is not that an inferior kind of Cornish boiler?

A. I have no reason to suppose that it is.

Q. Your attention is called to the following passage, page 70 of Box on Heat, already referred to. Referring to Cornish boilers, he says: Figure 27 shows the "best plan; the fire proceeding along the top to the back of the boiler, descends and returns beneath the body to the front, where it splits in pieces on both sides of the chimney; this mode of setting is preferable to any other," &c. Do you agree in that opinion with Mr. Box?

A. I think his statement is too general; it is certainly better than the other methods shown.

Q. Does not the rapidity with which heat passes through the flues at the top of the boiler depend somewhat upon the rapidity of consumption of fuel in the fire; in other words, if the fire was formed so as to produce a very rapid consumption, might it not take the heat through the boiler so rapidly as to decrease the ratio of heat that would be absorbed in making steam on its passage?

A. It would affect it slightly within the ordinary ranges of practice.

340 Q. Now, would not that rapidity be likely to be increased as you increase the amount of consumption of fuel in proportion to the grate surface of the furnace?

A. It would.

Q. Then would not the proportion between the amount of heating surface exposed in the boiler and the amount of fuel burnt affect the extent of the absorption of heat on its passage?

A. It would, slightly.

Q. Has not science developed a general proportion of ratio between the amount of fuel burnt per hour and the amount of heating surface in the boiler; or, in other words, is that proportion a matter of indifference, great or small?

A. That proportion is not a matter of indifference.

Q. It may then be too large, or it may be too small?

A. It may.

Q. Your attention is asked to the following quotation from a writer on furnaces: "Questions of the efficiency of steam-boilers and the due proportioning of fire grate and flues and heating surface, &c., to the capacity of boiler of engine, &c., are among those of great interest in the practical and commercial aspects of the subject." Do you agree with that author, and do you not understand him to indicate that a fit proportioning in the particulars referred to is required to secure greater economy of fuel and greater amount of evaporation in proportion to the fuel consumed?

A. I agree with him fully.

Q. Is it not true, as there stated, that what is called a multi-tubular boiler, being the kind of boiler mentioned as used at Binghamton, is a more economical boiler, for the reason that it exposed a larger surface for the absorption of heat than the later form of boilers?

A. The economy of fuel being equal, I say yes.

Q. Your attention is called to the 578th page, folio 1,726, of complainant's proofs, where Mr. Plumb was asked questions 142, 143, 144, and the answers to them; also to page 580, folio 1,733, questions 151, 152, and the answers to them. Now, then, do you agree with him in the views expressed there?

A. I do not entirely.

Q. State concisely how far you differ.

A. I disagree in so far as those replies are incompatible with my own.

Q. State what difference of theory or principle there is between you and him?

A. Mr. Plumb states in his reply to the 142d cross-question, folio 1,726, that the extent of boiler surface need not be taken into consideration when making comparative test under the same boiler with different quantities of fuel. I have stated that the extent of boiler surface does affect the result.

Q. Then do you not agree with what Box says in his work at page 124, section 229, as follows: "The quantity of water which can be evaporated to steam depends on the area exposed to the action of the fire"?

A. I do.

Q. And do you not agree with what he says at page 62, sec. 118, as follows: "The tubular boiler is, therefore, more effective than the ordinary one with the same actual surface"?

A. I do.

Q. And do you not agree with what he says on the same page, 62, sec. 119, as follows: "In fact, the area of fire grate should be proportioned to the area of boiler"?

A. I do not agree with the statement in the quotation as just given. The author evidently intends, as will be seen by the context, not

the actual area in the sense used in the question, but effective area in the sense of heating surface, and I agree with his meaning.

Q. Do you agree with the following statement of Box, page 58, sec. 113: "The area necessary for horse power varies somewhat with the size of the boiler. In small boilers it is not so effective in proportion to area as in large ones, the loss by radiation, &c., being so much greater in proportion to power"?

A. I do not fully, since the loss by radiation may or may not be much greater in proportion to the power.

Q. Does the furnace give the same evaporation per pound of combustible of some kind, whatever may be the rate, or irrespective of the rate of combustion per square foot of heating surface in the boiler in equal times?

A. It does not.

Q. Does not the increase of the heating surface within the limits referred to in Box increase the evaporating power or efficiency?

A. It does.

Q. Has your test taken into account or given any weight due to, or in anywise due to, a greater effective heating surface in the boiler at Binghamton, as compared with those at Sparrowbush, or the rate of consumption of fuel per hour, or the ratio of grate surface to boiler surface in the furnace at Sparrowbush?

A. I have taken that into consideration, and have placed the elements referred to in my statement of dimensions, but gave them no weight in my deductions, as there were no means of determining with precision what weight to give them. I did not consider that they would practically affect the result.

Q. Did not your deductions draw into account and depend upon the relative efficiency and capacity in the boilers at the two places to absorb heat and make steam as well as upon the relative merits of the two furnaces to economize the fuel and bring the heat derived from it to the boilers?

A. It depended upon both.

Q. Now, if you could have measured the extent and amount of heat that passed from the fire arch and furnaces to the boilers respectively, would not that have furnished an exact and reliable test of the efficiency of the two furnaces compared?

341 A. The extent and quantity of heat that there passed would have given this measurement.

Q. Do you mean to be understood as saying that on the assumption of an equal amount of heat per hour and per quantity of fuel used per hour from each of the furnaces tested, it would be a matter of indifference to the result, measured by the amount of steam evaporated as by your experiment, whether the boilers that might be affixed to such furnaces were such boilers, or whether such proportion of boiler surface therein as were used at Sparrowbush, or whether they were such boilers with such proportion of boiler surface as were used at Binghamton?

A. I do not.

Q. Suppose you have a furnace of a given capacity burning fuel at a given rate, and making a given amount of heat therefrom, and you attach to it just such boilers as there were in the Binghamton furnace, and keep up the fires for one hour, and then you attach to it such boilers as were used at Sparrowbush, and keep up the fire for one hour at the same rate, would a test of the comparative merits of the furnaces (and by furnaces I do not include boilers) be fair and just to the two, taking or computing the relative efficiency and amount of steam which might be made in the boilers respectively?.

A. It might or it might not.

Q. Would it not be fair unless there is an advantage in having tubular boilers or a greater amount of heating surface in the one case than in the other in proportion to the fuel consumed per hour, or the amount of heat that might go through the boilers?

A. It might or it might not.

Q. What are the conditions or elements which make it liable to go one way or the other; are there no definite scientific principles that govern it; if so, what are they?

A. If a set of boilers having the least heating surface reduce the temperature of the escaping gas to that required to produce draft, the introduction of boilers having a greater heating surface would not produce increase of efficiency.

Q. Can you quote any authority on that subject?

A. The statement is so evidently correct that I have not thought of looking for authorities in reference to it. I do not know whether I can produce such authority or not. I do not recollect ever having seen a case embodying the conditions here stated in any work, whether scientific or practical.

Q. Is the draft you refer to a draft in the chimney?

A. Yes.

Q. Is not your rejection of the several proportions referred to as elements of consumption and your omission to give any weight to the greater heating surface in proportion to boiler surface in making up your test due to the assumption that the boilers at Sparrowbush did in point of fact reduce the temperature of the gases, or, in other words, absorb so much heat as to leave no more than was necessary to produce such draft in the chimney?

A. I did not make the omission in consequence of having made that assumption.

Q. For what reason, then, did you make it?

A. I made the omission for the reason that, consistently with the method that I adopted throughout of giving the benefit of doubtful differences to the least efficient furnace, I was compelled to omit the consideration of the fact that the temperature of the chimney was lowest in the Sparrowbush furnace.

Q. If the effect was that the boiler at Sparrowbush did not absorb so much heat as to reduce the temperature to the maximum, or nearly the maximum, required for a draft, would you not, upon the basis of your answers, here find it necessary to regard the amount of a large

proportion of heating surface in the boiler as a circumstance to be taken into account in the estimate, and as one probably prejudicial to the efficiency of the Sparrowbush furnace?

A. Not necessarily.

Q. Why not?

A. Because the method of combustion adopted in the two cases was so entirely dissimilar that it became evident to my mind that the low temperature reached by the gases at Sparrowbush was due to an excessive proportion of atmospheric air mingling with them. A comparison of those furnaces, therefore, is not made upon the basis assumed in the hypothetical case presented a few moments ago by counsel.

Q. You assumed that the old-fashioned Cornish boiler was good enough in the Sparrowbush furnace, and was just as good as a multitubular boiler similar to the one at Binghamton, with a larger proportion of heating surface, did you not?

A. I made no assumption in regard to it.

Q. On the other hand, did you assume that such boiler as they had at Sparrowbush would have been just as efficient as if used at Binghamton?

A. I made no such assumption.

Q. Do you treat those matters referred to in the last two questions as indifferent points in your computation?

A. I do not.

Q. How are they material, then?

A. I consider this question as ordinarily important. In this case I obtained, as nearly as possible, a correct determination of the amount of heat produced in this set of furnaces, and, as in all such cases, was compelled to leave some points undetermined. Those points which were left undetermined in the case under consideration were examined, but in each case I came to the conclusion either that the differences of results that might have been produced by their determination were of no practical value, or else that they
342 had no practical value, and that if doubtful their determination would be most likely to fall slightly in favor of the less efficient form of furnace.

Q. Define concisely what those several points were, and do not encumber the record with any reasons why you treated them one way or the other, but state what they were.

A. The temperature of the gases leaving the chimney and the character of those gases were the most important points; I think of no more at this moment.

Q. The proportion of boiler surface and the intrinsic merits of the boiler are not of importance, are they?

A. Not in this comparison.

Q. Does not the result of your tests and your estimates depend in a considerable degree upon the correctness of what you have stated or inferred as to the temperature of the gases in the smoke stack, or after they passed the boiler at Sparrowbush?

A. As to comparative results, no; as to absolute results, it is so dependent, in a degree which I cannot precisely estimate, but consider small.

Q. Do you mean by comparative results the relative efficiency of the two furnaces?

A. I do.

Q. You mean by absolute results the relative efficiency of the Sparrowbush furnace?

A. No; by absolute results I mean the exact measure of the efficiency of each as compared with the common standard.

Q. Suppose in point of fact that the heat of the gases in the Sparrowbush furnace was 1,000 degrees, where you have assumed it to be 450, would not that affect the result?

A. Yes; absolutely and relatively, in my opinion.

Q. Then the conclusion of your experiment at Sparrowbush furnace does depend upon the question whether you were substantially correct in the estimated heat of those gases?

A. The conclusion as to absolute efficiency does depend upon it.

Q. If the furnace used at Sparrowbush had been a Thompson furnace of the form used at Binghamton, but with the same grate surface as the one actually used at Sparrowbush, would you have considered a boiler of the structure of those used at Sparrowbush as being as favorable for the test of such a Thompson furnace as boilers of the construction as actually used at Binghamton?

A. Such a substitution producing the result obtained at Sparrowbush would have shown the one to be of substantially the same efficiency as the other under those conditions.

Question repeated, and your attention is called to the fact that the question has nothing to do with results.

A. The question involves an hypothesis which I cannot conceive, and, except as producing differences of result, such a supposition is incompatible with the supposition assumed that the results of the trial would have been the same.

Q. What do you mean by results?

A. The results as given in my report of the tests.

Q. In the case supposed in the last question but one, would the evaporation of combustibles be the same?

A. I should expect not.

Q. Do you know of any rule for finding the relative efficiency of a furnace in reference to different rates of combustion per hour per square foot of heating surface?

A. I know of no reliable rule as given by any standard authority; the ratio is a geometrical ratio which has not, so far as my knowledge extends, been actually determined.

Q. Do you not know any rule that approximately determines it as accepted by standard writers?

A. I know of no definite rule.

Q. Do you recognize a book entitled "A Manual of the Steam

Engine and other Prime Movers," by W. J. M. Rankine, as an authority on the subject it treats of?

A. It is generally recognized, and I so recognize it, as our very best authority on the general theory of steam engine, but not as our best authority in engineering practice, or in the science of chemistry.

Q. Will you look at pages 293, 294, and 295 of this book, and state whether there is not a rule stated there, with illustrations, which marks the ratio of heating surface to the amount of fuel burnt per hour, and makes it a material consideration in tests such as that you have made?

A. I would like to have time to examine the book.

Q. Your attention is also called to a written statement, entitled "Efficiency of Boilers," containing extracts from said volume, and a computation and a table based upon the formula and principles laid down in the pages referred to, which computation and table are claimed to show, in conformity to Rankine, that the Sparrowbush furnace, upon your own showing in reference to the particulars of the experiment, is as economical and efficient in comparing results with the fuel used as the Binghamton furnace, or nearly so, and you are requested to answer in what respects said table and computation are erroneous, and the estimate of relative efficiency incorrect.

A. I will take the paper and examine it. The paper is marked "Exhibit No. 1," for defendant, Oct. 16th, 1864.

Q. Did you see the tubes so as to know whether there was any choking, as mentioned in paragraph 2 of your statement?

A. I did.

Q. I suppose 15 degrees of cooling in the feed water, mentioned in paragraph 3, is an estimate?

A. Yes.

Q. I suppose the making of a hole in the feed pipe and in-
343 serting a thermometer would have given an actual test, or true test, of the temperature of the water in both cases, would it not?

A. It would.

Q. Now, referring to your measurement of the flue at Binghamton, how long, wide, and high was the leach in which the tan was contained, and who put it into that leach, and when was it put in?

A. As I measured the leach, it was 15 feet 8 inches in diameter inside; the tan laid in it 5 feet 4 inches in depth; it was put into the leach in the regular course of work by the employes of the firm; I do not know when it was put in, but a sufficient length of time previous to have allowed of it being drained off and used.

Q. When did the few hours' draining mentioned in the eighth paragraph of your statement begin and end?

A. It ended at this trial; when it began I am not certain.

Q. Was this what is called an Allen & Warren leach?

A. I do not know; it was a round leach.

Q. Have you had any knowledge or practice in wet tan before you were employed in these tests?

A. I had no such practical knowledge.

Q. Are you not aware that wet tan is an elastic or compressible substance, which will hold its position at varying degrees of compression?

A. I am.

Q. Who took out the 34-100 of a cord from the leach at Binghamton; were you or not present when it was taken out?

A. It was taken out by the employes of the firm, not in my presence; I examined it after being shoveled out.

Q. Do you know whether they got into the leach to shovel it?

A. I did not investigate that matter, and do not know.

Q. Did you go and examine the leach after it was shoveled out?

A. I did.

Q. Had it been taken pretty uniformly over the top, or what was the shape and character of the place left vacant by its being taken out?

A. I did not consider that important, and did not investigate it.

Q. Now would not a weight of over 4,400 pounds of that material in the leach give a greater density to it at the bottom than at the top?

A. I do not think the difference would be appreciable.

Q. Is that opinion based on any experiment in regard to the tan in that particular?

A. Yes; I examined the leach occasionally as the tan was removed from it in each case, and concluded that as I could not detect those differences—which told in favor of the Sparrowbush furnace—it was not worth while measuring them with perfect accuracy.

(Answer objected to by defendants' counsel, so far as it relates to the Sparrowbush furnace, as not responsive, and a voluntary statement calculated to prejudice the defense.)

Q. How do you reconcile your answer to the last question, so far as it relates to Binghamton, with the answers you have previously given as to the taking out of the tan, or the condition of what you observed of the tan left?

A. I do not see anything irreconcilable in those replies; the condition of the tan in the leach is quite different from the tan taken out, the latter being loosened up by the act of removal.

Q. Was the compressed tan taken out at Binghamton before its measurement?

A. It was done by an employe of Weed & Co., whose name I do not know.

Q. Were you present when that was done?

A. I was not.

Q. You assumed, on your measurement, that the part taken out and measured was of equal density to the average density of what was left, did you not?

A. I did not.

Q. Then upon what theory did you compute the total weight or quantity from the part taken out?

A. I had the tan which was taken out weighed, not precisely for the purpose of determining exactly the weight of fuel used in either case, but for the purpose of obtaining a standard approximately correct, with which to compare the volume of fuel used in both cases.

Q. You measured what you took out—the cubic contents of what you took out?

A. Yes.

Q. And compared it with the cubic contents of the whole, and you found the ratio of the one to the other to be as one to thirty, did you not?

A. The ratio of weights of the part taken out to the total weight I make to be about one to twenty-five.

Q. You assumed that the weight of tan in the leach was 4,494 80-100 pounds by estimating it on the basis that the 34-100 cubic feet in the leach was of the same weight as the 34 cubic feet you took out, as compared?

A. Yes.

Q. Now, then, if there was any error in respect to the compression of the part taken out being equal to the compression of the part left in, or the whole tan in the leach, would there not be an error as to the whole weight, and would not that error be increased twenty-five times above the error in the measurement of the part taken out?

A. It would.

Q. How, then, can you swear to the approximate truth of the estimated weight of the tan in the leach at Binghamton, except upon the assumption that the pressure of that taken out as compressed was almost precisely the same as the effect of pressure of what was left in?

A. I made the estimate after a comparison of the two masses of tan, outside the leach and in the leach; it is not a pure assumption.

Q. Did not your cord of tan weigh 5,447 pounds, and does not Mr. Du Faur's weigh 4,375 pounds, and Mr. Plumb's 4,500
344 pounds?

A. These are the figures as I recollect them.

Q. Would not your results need to be reduced 20 per cent. to bring them into conformity with Mr. Du Faur's as to the efficiency per cord?

A. They would.

Q. Referring to the leech at Sparrowbush, was it measured to see that it was half full, or how did you get at what you call half a leach?

A. The workmen were instructed to leave half the tan in the leach, and I measured it previous to the trial.

Q. Was the tan all removed from the top of the furnace before you commenced your experiment at Binghamton?

A. It was.

Q. How many times did you determine during the experiments the time it took to reduce the water level in the box one foot?

A. I have no record of the number of times; I should think six or eight, possibly ten.

Q. Do you mean to say that the average every time was exactly four minutes?

A. Every time it was very nearly exactly four minutes as nearly as I could time it by my watch; the time sometimes fell two or three seconds short; I did not in any instance find it to be more than four minutes, and have taken four minutes as being so nearly correct that the real result cannot have been affected favorably in any important degree by one or two seconds.

Q. Were you in presence of the engine that worked that pump during the whole thirteen hours of the experiment? Please answer yes or no.

A. No.

Q. You corrected one of the three experiments to test the priming in the Binghamton engine, and the one corrected was the most favorable to that boiler of the three?

A. The one corrected was the most favorable.

Q. What difference in result would it have made if you had allowed it to remain uncorrected, and what would have been the effect on the result if you had rejected it altogether?

A. I have not estimated it.

Q. Now is it not customary to act on fixed rules in rejecting experiments or accepting them in tests of this nature?

A. It is.

Q. Are not such rules laid down in Professor Pierce's work?

A. I don't know.

Q. Did you ever read what he has to say on the subject of rejecting or accepting unsatisfactery experiments?

A. I do not now remember.

Q. Of course you do not know whether your method of dealing with it conforms to what his treatise lays down?

A. I do not.

Q. Can you state whether Professor Pierce is not a high authority on such subjects?

A. I think not.

Q Do you not know that the United States Coast Survey uses this work for the correction of possible errors or the rejection of possible errors in a series of observations?

A. I believe it is used in the work which they are called on to do.

Q. Of the three experiments, is not one of those adopted a very indifferent test, running over thirteen hours, especially in view of the fact that opportunity was before you of making effective tests, and in view of the facts that at Sparrowbush there were four tests in nine hours?

A. I do not so consider it.

Q. Pretty immaterial whether the tests were two or ten?

A. In this case I do not consider it wholly immaterial, and I do not consider it exceedingly important.

Q. What is the cause of priming?

A. A supply of heat to a mass of water so rapid that it cannot be

carried off by the steam without inducing such violent action as shall produce a mechanical suspension of the particles of water in the current of steam.

Q. Do I correctly understand from your experiment that the priming at Sparrowbush was about twice what it was at Binghamton?

A. Approximately.

Q. Then if you increase the heat in a furnace, and supply the gases in a more and more highly heated state to the boilers, that would tend to increase the priming, would it not?

A. With any given boiler it would.

Q. Upon the basis of your explanation of the cause of priming, why does not the double amount of priming at Sparrowbush tend to show that a higher degree of heat was supplied to the surface of the boiler than to that at Binghamton?

A. Because the boilers are not the same.

Q. On the assumption that wet tan was of more pecuniary value at Laporte, Albion and Thorndale, which we are alleged to have infringed in this case, will you explain how anything contained in your evidence here shows, and to what extent it tends to show, that defendants made any pecuniary or other gains by using the alleged infringing furnaces at the places named; or, in other words, state what pecuniary gain you deduce by your experiments, or furnish any basis for deducing?

(Objected to, subject to being ruled upon by the master.)

A. I have not considered that question and have made no estimate.

Q. As a rule, is not a tall chimney more favorable to efficiency in a furnace than a shorter one?

A. As a rule it is not more favorable to economic efficiency.

Q. Is it not more favorable to efficiency in the action of the furnace irrespective of the extra cost of the chimney?

A. As a rule it is not.

Q. In the case of those furnaces, which do you consider was the better chimney—the one 70 or the one 90 feet high?

345 A. I should prefer, all things considered, the high chimney.

Q. Your attention is now called to the two unanswered questions of your last examination, one beginning, "Will you look at pages 293, &c.," and the other beginning, "Your attention is also called to a written statement entitled 'Efficiency of Boilers, &c.,'" and you are requested to answer the two questions now referred to you?

A. The first question refers to a formula which is given by Prof. Rankin in his work on "Prime Movers," and the second question refers to a paper in which it is attempted to show that this formula proves, when applied to the cases under consideration, that the Sparrowbush and Binghamton furnaces are shown by complainants' experiments to be practically of equal efficiency. I will reply to both as follows: The paper marked Defts' Exhibit No. 1, Oct. 16th, 1874, I find to be interesting, skillfully prepared, and valuable in the pres-

ent case, provided what is claimed for it is correct; but it is founded on an incorrect hypothesis, and is partially based on false assumptions; I am confident that it is not true that the formula applies accurately to the present case, and there is no evidence that it is even approximately correct; the assumption that priming is equal in the several experiments made by the defendants, and of the same amount in the experiments both of the complainant and the defendant, is a mere assumption, and may be very far from correct; examining the paper here referred to, I have come to the following conclusions: The formula is evidently intended by its author only to apply to ordinary British engineering practice, in which the most important elements differ very essentially from the practice which we have here to consider; in all of Rankin's experiments the same fuel is used; the same temperature of fire is assumed in all of those experiments; the fuel is North Country coal and coke; the temperature of the fire is taken at 2,400° Fahr. (see page 292;) the author only claims (see page 293) "an approximate degree of accuracy," even under these conditions; again, the constant A, as he says here, "is to be found empirically," and is "approximately proportional to the square of the quantity of air supplied per pound of fuel;" this fact of the variation of a "constant" in any formula, and by a power higher than the first, is evidence of the inapplicability of the formula to more than a restricted range, and also of the fact which also is admitted that it is partly empirical; the author says it is of course not intended to supersede experiments and practical trials, nor to give results as accurate and satisfactory as such experiments and trials, but to furnish convenient means of estimating approximately the evaporative power of fuel in proposed boilers, and the comparative efficiency of different boilers; again, he introduces an hypothesis, and says explicitly "the formula is framed on the supposition that the admission of air and the management of the fire are such that no appreciable loss occurs, either from imperfect combustion or excess of air, the construction and proportions of the furnace, and the mode of using it, being *the best possible for each kind of coal*."

The italics are mine. The several examples of application show the formula to be applicable with the practical and useful accuracy within the range of practice illustrated there; that is, with bituminous coal, and with the range of proportions of steam boilers common with that fuel; within this range the formula is very convenient and perfectly satisfactory; there is nothing, however, to indicate whether it applies in a comparison of the cases considered in this suit, in which two rival furnaces are constructed for burning a material widely different from that contemplated by the author of this formula, or with a temperature of furnace, on the one hand, fifty per cent. lower, and on the other, fifty per cent. higher than what he states to be the temperature of his illustration, or as in this case, in which one furnace uses at least twice as much air per pound of combustible as the other, the author himself says (page 297) that, at the

higher limit of even ordinary locomotive practice, his formula gives results which are not accurate.

Still again, testing the formula by a usual mathematical device, we find it to give results absolutely and comparatively wrong. Taking the form as here given in Defendants' Exhibit No. 1, Oct. 16th, 1874, *i. e.*,

$$\frac{E'}{E} = \frac{11}{12(+10.5\ \frac{F}{S}}$$

and making S=infinity, we obtain the highest possible value of

$$\frac{E'}{E} = 0.92$$

even in a heating furnace of infinite extent. Comparing differently proportioned heating surfaces, having a ratio to each other of, for example, 60 to 1, we find that the second has an efficiency of only 1-10 of the first; but Chas. Wye Williams found that the first inch of a tube, five feet long, evaporated 25 per cent. of the total evaporation of the tube. Mr. Dewrance says that he finds by his experiments that only the first two feet of the tube have any practical value. Benjamin Hick says that he finds that the first six inches of the tube of as much value as the succeeding sixty inches, in a tube
346 sixty-six inches long. (See Chas. Wye Williams "On the Steam Generating Power of Marine and Locomotive Boilers;" second edition, London, 1864.) Next examining the formula again, we find no factor referring to the temperature of the furnace. But Rankine states (page 265) that the rate of conduction—and consequently the value of heating surface in transmitting heat—varies the square of the difference in temperature of the media which it separates. In the case which we are here examining, we have a Thompson furnace in which we have a temperature exceeding that of the boiler itself, about 2.4 times as much as occurs in the Crockett furnace, and it follows that the action of the heating surface first met by the gaseous products of combustion is several times as efficient with a Thompson as with a Crockett furnace, while the heating surfaces near the chimney are similarly rendered comparatively valueless in a Thompson and valuable in a Crockett furnace.

It follows as an evident fact that the reduction of the heating surface in a Thompson furnace would reduce its efficiency in some unknown but very small ratio, and would have a comparatively insignificant effect, but that a most important loss must occur, with a similar reduction, in the Crockett furnace.

To get some idea of the relative value of heating surfaces in both, it is necessary to vary the "constant" A inversely, as the square of the elevation of temperature in each, above the atmosphere. This is seen by studying Rankine's definition of his constant A. Then making A vary as one divided by the square of the difference of temperature, I get for the Crockett furnace, A=2.72; for the Thompson

furnace, A=0.24; and the value of the efficiency, thus theoretically determined, becomes for the Thompson 0.78 and for the Crockett 0.21. But as in the Defendants' Exhibit No. 1, Oct. 16th, 1872, in the table in column headed $\frac{E'}{E}$, this value is estimated at 0.69 for the Thompson and 0.51 for the Crockett furnace, the relative value of their efficiencies, as determined by the original and revised formulas, is $\frac{69}{78}$=0.88 in the Thompson furnace and $\frac{51}{21}$=2.43 of the assumed value. By converse reasoning, based upon these relations, the heat wasted in the Crockett furnace must be approximately $\frac{2.43}{0.88}$=2.76 times as much in the Crockett as in the Thompson furnace. This is actually $\frac{0.34}{0.15}$=2.27 times as much.

What we have done here is to introduce a new factor, and its influence in changing the result is taken as indicative of the value of the other omitted factor, which is concerned in producing the assumed conditions of the formula. The estimated absolute measures of the efficiency, as determined by the modified formula, are, of course, only relatively correct.

The correspondence of theory with the experimental determination of efficiency, as noted in the defendants' exhibit, is due simply to the coincidence that the difference in value of the heating surface is inversely proportioned very nearly to the difference in the value of the heating efficiency of the two furnaces. The Thompson furnace happens to have an average value of heating surface per unit of area which is less than Rankine's practice, and which is closely proportionate to its superior heat-producing power, while in the Crockett furnace the mean value of heating surface is higher than Rankine assumes, in almost precisely the proportion in which its furnace has not so great efficiency. In comparing the columns headed "theoretical efficiency" for No. 2 as a unit, and the "efficiency by experiment" for No. 2 as a unit, using the equivalent evaporation at 212° from the boiler, therefore, we find that Rankine's formula gives the relative efficiency of the two furnaces at 1.35 to 1, while my own experiments show it to be practically the same, 1.33 to 1. But the absolute values of sufficiency, as given in the column headed "theoretical efficiency," $\frac{E'}{E}$, are very far wrong, and prove the inapplicability of this formula in

the one case, while the remarkable variation and incongruity of results of the defendants' experiments, as obtained by comparing the two columns first referred to, indicate a serious inaccuracy in those trials, which may be due to the false assumption on which those estimates are based, that the priming was the same at all of the trials; or it may be due to the bad management of the furnace, or to errors entering into the record. Referring to that table, "Sparrowbush trial (3)," we find that it gives results which are apparently 1—7-9=0.222—that is, more than 22 per cent. astray. Examining those at Laporte (4) we find the result 1—65-78=0.166, or about 17 per cent. wrong. At Laporte (5) it is 1—81-1.08=0.25, or 25 per cent. wrong, if it is admitted that the assumption which forms the basis of Defendants' Exhibit No. 1, Oct. 10th, 1874, is correct. These differences are not simply variations of theory and practice, but the same furnaces in experiments (4) and (5) give what I have shown to
347 be incongruous and fatally inaccurate discrepancies and errors,
which are $\frac{25}{17}$ — 1=0.48, or 48 per cent., greater in one case than in the other. These facts seems to me fatal against the presumption of accuracy in these returns which are produced in evidence by the defendants; I will only further state that those varying results, if accepted, would compel the deduction that the relative market value of engineering devices should be determined by conditions themselves variable; but we cannot gauge values by variable standards; the proper method, as I consider it, is to obtain the best results possible from each, and then to judge those results and those values by such determinations; this I have endeavored to do critically, conscientiously, and accurately; nothing in the exhibit here presented, so far as I can see, affects in any manner the value of my work, but it does exhibit the defective character of the cases [3] [4] [5] in this table, presented as exhibiting the results of the defendants' trials; the paper presented by the defendants simply proves what the complainant insists upon—the superior efficiency of the Thompson furnace, and the gratifying results of the complainant's trial of the furnaces; it follows then from the facts here and previously stated, that the diminution of heating surface at the Thompson furnace to the proportion found in a Crockett furnace would diminish its efficiency slightly; it follows also, from the facts observed at Sparrowbush, that the extension of heating surface over a Crockett furnace would impede its draft and check its fire, and perhaps bring down the temperature of its furnace still lower, thus rendering the whole apparatus more inefficient than it is at present, if not absolutely checking its operation.

Q. Do you present your test as showing the relative efficiency of a Thompson furnace and one that is not a Thompson furnace, or as showing the relative efficiency of two Thompson furnaces?

A. As showing the relative efficiency of a furnace having all the essential features of a Thompson, and of another furnace in which some of those features appear but very lightly.

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Q. State what essential feature of a Thompson furnace you declare to be in a Crockett furnace.

A. The Crockett furnace tested contained the so-called Thompson "feature," that the gases of combustion and distillation mingled in a flue or chamber on their way to the stack and to the boiler, as described in Thompson's reissued patent; it also, as operated at that time, contained a feature described in Thompson's second patent, namely, the presence of fire both above and below the grates.

Q. Are you not aware that what Thompson calls a mixing chamber is a place where those products of combustion and distillation mix and consume each other on their way to the boiler?

A. Not precisely.

Q. Are you aware that the Crockett furnace referred to is the same or just such a furnace at was standing and in use when Thompson made his invention, and has been declared by the court not to be a Thompson furnace?

A. I am not.

Q. Supposing the assumptien in the last question was true, would it in anywise affect the views you have expressed about a mixing chamber, and if so, how?

A. It would not affect my views, except with the additional assumption that such furnace was practically successful in the manner in which the Sparrowbush furnace is claimed to be successful.

Q. Your attention is called to this language in the opinion of the judge, "there is nothing in the Crockett furnace, or in the Morrison furnace, or in the Woodstock, Sparrowbush or Newark furnaces, or any of the other American furnaces adduced in evidence, so far as such furnaces are shown to have existed in construction, or in descriptions or drawings before the date of Thompson's invention, which destroys the novelty of those inventions; to what extent they did, they did so on different principles from those developed by him in structures arranged and operated in a manner not embraced in his claim;" do you agree in the view of the judge?

A. A reply to that question would necessitate a previous review of the evidence and a study of questions involved in the case which I have not examined; I am therefore not prepared to say.

Q. Now, referring to your table headed "Relative efficiency of Crockett," where you put the Thompson at 1 33-100ths to Crockett 1, state what presentage of greater efficiency of Thompson is there given as deduced from or dependent upon excess in amount of priming in Crockett furnace.

A. I have not taken the trouble to estimate it.

Q. Will you please state it as near as you can?

A. A hasty estimate makes it about one and seven-tenths per cent.

Q. I think your attention has not been previously directed to Rankine's formula referred to by you in evidence; now, have you made any experiments upon the slow or rapid consumption of fire in a furnace, or, with a large and small ratio of boiler surface, of the rate of

consumption per hour, or otherwise, of any kind to test the accuracy of that formula for one and the same furnace, or for different furnaces?

348 A. My attention has been called to this formula by the fact that I have used the work referred to as a text book, and this formula forms a part of my course of instruction; I have made experiments upon boilers of various forms and proportions, and have compared the results of such experiments with the formula.

Q. Do you mean experiments in which you used wet tan or other wet fuel?

A. No, sir, except in the present case.

Q. And by "present case" you refer to the experiments you had previously stated here?

A. Yes, sir.

Q. Taking your experiments as a whole, were they intended to show, and what do they show—the ratio of heat to fuel consumed and utilized through the boilers, or the whole amount of heat in the ratio of heat to fuel made in the furnaces?

A. They are intended to show very accurately the absolute amount of heat utilized by the boilers from the furnaces, and the relative amount of heat so utilized to the total amount of heat generated, and also the absolute efficiency of fuel in each case.

Q. If they show the relative amount of all the heat made from the same amount of fuel in the two furnaces, or the ratio of heat to fuel in either of the furnaces as separate from the amount utilized, will you state how that absolute amount is shown, and where it appears?

A. It is found in the table of results, where it will be noted that the efficiencies are given relatively, taking the fuel with and again without its water; it is also shown in greater detail in the conclusions immediately preceding that table, paragraphs 39, 40, 41, 42 and 43.

Q. Is there any heat measured in the place referred to in the last answer except the utilized heat?

A. Yes, sir.

Q. Point to any figures showing it.

A. The last two columns in the table exhibit how much heat passes off unutilized; one is headed 64-100ths, and the other 85-100ths.

Q. According to your view, then, those columns measure the ratio of heat that goes up the chimney unutilized to the ratio of heat absorbed by the boilers in the two cases?

A. The next to the last column measures it; the last column indicates the proportion of heat so wasted to the total generated from the dry portion of the combustible.

Q. Now, upon what measurement or test in your experiments does the correctness in each of those two last columns rest?

A. Upon the measurement of the amount of steam made and water heated, and upon the measurement made by every chemist of

the heating power of dry wood, and upon my measurement of the moisture in this fuel.

Q. Taking the heating power of fuel as estimated by chemists, and taking your tests of the amount of heat utilized, and your measurement of the amount of water in the tan as being correct, those three elements alone would not show the ratio of heat that was utilized in either case, would they?

A. Taken with the measure of the fuel used, which I inadvertently omitted in my last answer, it would.

Q. Does not that way of reckoning it assume that the furnaces developed all the heat which the fuel was capable of making?

A. No, sir.

Q. Did you in anywise measure the amount of heat escaping by the chimney unutilized; if so, how did you measure it, and where is reference made to it in your statement?

A. In the Thompson furnace I measured the temperature of the escaping gases, fronr which I can readily determine the temperature of the furnace and the amount of air supplied to the furnace, [Counsel for defendants objects to the answer as irrelevant, and asks the witness to give an answer directly to the point. Witness adds] consequently the volume of gases passing off from the furnace and the amount of heat which they contain; this is what is wasted, and is the heat to which reference is made by the counsel; at the Crockett furnace I determined the maximum above which the products of combustion had not risen in temperature; I then made an estimate of the probable correct temperature within that maximum, and, proceeding on this basis, it was easy to obtain a more accurate conclusion as to the amount of heat wasted by that furnace; those results may be used to check the figures given as representing the efficiency of the two furnaces, as determined by the measurement of the remaining portion of the heat; the results are, probably, not mathematically correct, but are practically so; the whole report indicates how the measure of one portion of heat was obtained; the temperature of the chimney from which the amount of the other portion was deduced by deducting from unity the percentage just referred to is given in paragraph 23 and paragraphs 33 and 34.

Q. If you had measured the area of the top of the chimney, and the temperature of what was passing out of it, and the rate at which it moves out of the chimney, could you have estimated correctly the amount of heat that was unutilized?

A. I could.

Q. Did you make any such measurement?

A. I did not.

Q. Did you measure, and if so, how, the heat within the furnace, either at Sparrowbush or Binghamton; if so, what was that heat in either place, and in what part of the furnace was the degree of heat taken in either case?

A. The temperature of the furnaces was calculated, not measured;

at the Thompson furnace it was a mean 3,209° Fah.; at the
349 Crockett furnace it did not exceed 1,373° Fah.; the estimate of most probable value is 1,158°.

Q. I believe you stated nothing of that kind in your direct examination, did you?

A. I did not.

Q. Now, when you state that the temperature of the Binghamton furnace was what you say, do you mean that that temperature would have been disclosed by inserting a metal into the body of the furnace above the flame; do you mean that that metal would have fused at 3,209° by inserting it into the body of the Thompson furnace, above the flame; is that what we are to understand?

A. I should consider that it would.

Q. At what degree does wrought iron melt; take English hammered wrought iron?

A. At a temperature so high that it has never to my knowledge been measured.

Q. Is the heat you give for a Thompson furnace equal to the white heat of brick?

A. I presume it is higher than white heat.

Q. Might you not have tested the heat of that furnace by taking some metal, such as zinc, that would have measured the heat, to see how much it was?

A. I presume I might.

Q. Is not that a common way of testing the heat of furnaces?

A. It is a very common way.

Q. Are you not aware, sir, that Prof. Chandler, of the School of Mines, in this city, made experiments in this direction, and actually tested the heat of furnaces in that way; is he not a man of first class ability in the line of science in which that subject is embraced?

A. I am aware that Professor Chandler made experiments in this direction, but I do not know the details and cannot judge of their accuracy; he is a man of distinguished ability.

Q. Now, at what temperature does zinc melt?

A. Zinc melts at points variously given by different authorities, from 720° to 800° Fahr.

Q. At what point would it go into fumes?

A. I cannot state exactly.

Q. Now, in your opinion, in a Thompson furnace like that at Binghamton, is or is not a mixing chamber hotter than the portion of the furnace near its mouth?

A. I should suppose that the temperature of the gases passing through the mixing chamber would be practically as high, probably higher, than the temperature of the furnace.

Q. According to the theory of Thompson's patent, as you understand it, does he not aim and assume to get heat passing in the mixing chamber where the gases mingle and consume each other?

A. I should infer that he did.

Q. Now your attention is called to the examination of Professor

Chandler, contained in defendant's answer and proofs, beginning at page 642, and especially to pages 645 and 646, folios 1,932 and 1,933, where the professor shows the actual test of this Binghamton furnace, and estimates it at from 1,500° to 1,600° Fahr., and you are asked to state, if you can, why that test is not reliable?

A. I have examined the testimony referred to, and I see nothing in that testimony which I would feel justified in criticising.

Q. Now, sir, state first, succinctly, every fact of observation, and every rule of science on which you base your opinion that this Thompson furnace had an average heat of more than 3,000°.

A. I found by observation the temperature of the gases escaping to the chimney, and I determined the excess of that temperature above the temperature of the atmosphere as determined by observation; I determined the amount of actually utilized heat, and the relation which it bore to the amount of heat which the same fuel would yield were it burned in a perfect furnace; the ratio of excess of temperature just mentioned to the temperature of the furnace will bear a close coincidence with the ratio existing between the lost heat and the utilized heat, as shown in Rankine, page 292, sec. 4, introductory paragraph; I also examined the condition of the fire as frequently as possible, when the feed-hole covers were removed, and found that usually the gases in the whole interior of the furnace were in a state of incandescence, and the temperature as estimated by this kind of observation was so high that it gave me no reason to doubt the results of the calculation made in the manner just shown; I was further confirmed in my estimate and calculation by the fact that those fusnaces were, through the trial, so far as I could judge by observation, performing remarkably well; they were carefully attended, skillfully fired, and worked uniformly and satisfactorily in every respect, and I believe the temperature thus attained to have been the practical maximum for such furnaces.

Q. Did you test the heat of what escaped from the chimney in any other manner than is explained in the statement handed in on your first day's examination?

A. I did not.

Q. Will you state at what temperature cast iron melts?

A. The melting point of cast iron, as given by various authorities, ranges from 2,744° to somewhat less than 3,000°; I have seen one statement of 27,000°, which I do not believe to be even approximately correct.

Q. State at what point copper will melt?

A. Copper is said to melt at about 2,000°.

Q. Your attention is called to the table on page 46 of Box on Heat, already referred to, in which he gives the temperature of the air as it leaves the fire in furnaces burning coal, coke, wood, peat; also the temperature of the air which goes from the furnace under the boiler as it passes through the flues at the top of the boiler, and they are for a coal fire with a brick furnace 2,252°; for a coke fire, 2,089°; for wood artifically dried, 2,173°; for wood

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in its ordinary state, 2,091°; and for peat, 2,211°; and the corresponding figures indicating the heat when passing through the flues in the boiler as follows: 1,279°, 1,188°, 1,869°, 1,797°, and 1,274°; and as you have stated that your experiment did not show that a Thompson furnace would develop a greater amount of heat out of wet fuel than the other furnace would develop out of dry, how do you reconcile those statements of Box with your statements as to the heat of a Thompson furnace?

A. By a consideration of two facts—first, that the furnace referred to by Box was not worked under the exceptional conditions existing with the Thompson furnace; and, second, that the temperatures given by Box in every case are lower than those which I believe to represent good average practice, particularly as they are lower in every case to the extent of half of those given by Rankine as the temperature of the ordinary coal fire. (See page 292, already referred to as authority in Defendants' Exhibit No. 1, Oct. 16th, 1874.)

Q. Now, as Rankine, at page 292, to which you refer, gives no other estimate of heat than one at 2,400° above that of the external air, and Box gives for coals 2,252°, will you state upon what authority you say that Box is one-half of Rankine?

A. As just stated in my previous answer, I compare Box and Rankine in their statements of the temperatures in steam-boiler practice. (See Box, page 46, table, next to the last column.) The evident discrepancy there, and the fact that the temperatures of furnaces vary according to known laws, with the character of the fuel, is sufficient as authority. Also the temperature given by Box as that of a coal fire, in a fire-brick furnace even, is lower than [answer objected to as irresponsive and irrelevant. Witness continues—] Rankine's figures for a coal fire in a steam-boiler furnace.

Q. Can you quote from Rankine or any other authority any statement to the effect that the heat in a furnace is ever higher than 2,400°, as stated on page 290, referred to by you, plus the temperature of the external air?

A. Paragraphs 231, pages 283 and 284, paragraph 233, pages 285 and 286, noting particularly the table of temperatures and volume of gases on the latter page.

Q. In paragraph 231, at page 284, quoted by you, Rankine has given pure carbon and olefiant gas as a fuel, and heads a table as follows: "If diluted with air for combustion," and then states the elevation of the temperature in the furnace for carbon 2,440°, and for olefiant gas 2,710°, does he not?

A. He does.

Q. You say the decrease of heating surface in a Thompson furnace would be of little damage; might that decrease be continued on indefinitely with little damage?

A. It might not.

Q. You say that the increase of boiler surface in a Crockett furnace would bring down the draft and make the furnace less efficient

than it is; did you make any experiment with that furnace to see that that would be the effect?

A. I did not.

Q. Ought not the boiler surface to be so large in proportion to the heat developed from the furnace and passing along the boiler as to absorb all the heat possible consistent with an adequate draft in the chimney?

A. It should.

Q. Did you make any experiments with the larger boiler surface attached to the Crockett furnace, so as to show whether more heat might be safely absorbed?

A. I did not.

Q. If the amount in proportion of heat that went up the chimney unutilized in the Crockett furnace to the whole heat made was one-third or twice as great, would it not show that it would be a gain to have a larger ratio of boiler surface?

A. Not necessarily.

Q. Do you intend to say, or would it be just to draw from your statement the inference, that the boiler surface of the Binghamton furnace was any less large in proportion to the fuel consumed per hour, or in proportion to the grate surface?

A. I think it would.

Q. You think the boiler surface was too large, then—in excess of what economy would require?

A. Not in excess of what economy would require, but only in excess of what general efficiency, all things considered, would require.

Q. How do you reconcile that view of the matter with the statement you have made that the gases passed out of the chimney of the Binghamton furnace at a higher heat than at Crockett's?

A. Rankine gives the proper temperature for natural draft at about 2 5-12ths of the absolute temperature of the atmosphere; this would make the proper temperature of the draft at Binghamton 645° Fahr. and 678° at Sparrowbush; by decreasing the area of heating surface at Binghamton, the temperature of the escaping gases would have been slightly raised, effecting a slight decrease of economic efficiency without inconvenience, and with economy of first cost; at Sparrowbush the temperature was further below the proper temperature than at Binghamton, but the decrease of heating surface there
351 would reduce the efficiency in a higher ratio, and take away the efficiency where it could least be spared.

Q. Please calculate the theoretical temperature developed by a vegetable fuel containing 59 per cent. of hygroscopic water, and where this 59 per cent. of water is evaporated during combustion, and mixed with the products of combustion, it being understood that the 41 per cent. of dry matter is nearly about one-half carbon.

A. I will do so.

(The witness desired to make a statement.

The statement was received subject to the right of objection to be made at this session to the statement, or to any part of it.)

The witness then made the following statement:

I desire to make an amendment to statement made October 23d relative to defendants' "Exhibit No. 1, October 16, 1874," and to replies to the succeeding interrogatories. I have since had time to examine the question more deliberately, and have found some illustrations, in actual practice, of the fact then stated, that the formula presented October 16th is only applicable to ordinary practice, and within a limited range. In the case to which it is now sought to apply the formula, the

$$\frac{F}{S}$$

ordinary values of — are not obtained,

and the value of S is very much smaller than usual. The actual relative temperature of furnace differs almost as widely as the hypothetical temperature previously given in illustration. It should be stated here that the temperature 3,209° F., given previously, is that which would, were the case one of ordinary practice, with dry coal as fuel, have given the absolute efficiency found here—0.85. It is not the actual temperature of furnace in these experiments. It is that of an hypothetical case. Rankine gives the temperature of furnace in his examples at 2,400° F. This is probably a fair estimate of average temperature. (A.) With a closed ash pit it is a common experience to find the cast-iron grate melted down in ordinary steam-boiler furnaces. I have known this to occur in a small house furnace with an ordinary coal fire; the experience of Thompson, which drove him to use fire brick in place of iron grates, is an illustration of the same high temperature occurring in his practice; this proves the temperature of furnace to rise occasionally to a point not far removed from 3,000° F., which may be taken as the higher limit in such cases and corresponding to an air supply one-half greater than is needed for perfect combustion, a proposition which (B) Rankine also states to occur in practice. In the Thompson furnace, at my test of its efficiency, the fuel released a sufficient quantity of heat during its combustion to have raised its gases to a temperature which would also be very high—3,209°, as already given—were not this heat diffused through the large volume of steam mingled with those gases, and were it not to some extent absorbed and rendered latent by the evaporation of water; this reduces the real temperature about one-third. (C.) Calculating the actual temperature of furnace from the ascertained temperature of chimney flue, and comparing it with that which the fuel is capable of yielding as a maximum, these temperatures are found very nearly the same. This indicates the actual proportion of air supplied to be approximately that required for combustion, and without allowance for dilution. (D.) The air supply is, in the Thompson furnace, restricted by nearly closing up the ash pits, and by a method of feeding which insures that little, if any, air can enter with the fresh charge of fuel. (E.) This restricted air supply, which is claimed by Thompson in his specifications and instructions as distinguished his method of consuming

wet fuel, and which is one of the most striking characteristics by which it differs from the usual practice of which Rankine treats, is thus well illustrated by the action of the Thompson furnace at Binghamton. (F.) But while the Thompson furnace is thus remarkable for its singularly restricted air supply, and by the consequent efficiency due to high temperature, the Crockett furnace is equally remarkable for the excessive large volume of air passing through it, diluting the furnace gases, reducing their temperature and lessening the efficiency of the furnace. This furnace varies from ordinary practice principally in this feature. (G.) At my trial the furnace doors were thrown open at intervals of from seven to nine minutes for the purpose of throwing in fresh fuel, and large quantities of cold air were thus introduced; the fuel was bulky and burned irregularly into holes, through which air could pass up into the furnace from the ash pit with comparative freedom. (H.) The quantity of air per square foot of grate and per hour was apparently far in excess of that passing through the furnace in ordinary steam-boiler practice, in which the furnaces are charged about once in fifteen or twenty minutes, when burning ten to fifteen pounds of coal on the square foot of grate per hour. A pound of wet tan-bark, of which not far from twenty pounds were burned in the Crockett furnace per square foot of grate per hour, contains but about one-fourth of a pound of carbon. A pound of good coal contains more than 90 per cent. of heat-producing material, with the same air supply, per square foot of grate per hour. The Crockett fur-
352 nace would thus take at least twice as much air per pound of carbon as a coal fire. Taking Rankine's estimate for ordinary practice—a supply double that required by theory—as a basis for comparison, we should have had at the Crockett furnace four times the actually-required quantity of air, and the gaseous products of combustion would have been so much diluted that the temperature of furnace would have been below 1,000° F., and the temperature of chimney flue below 450° F. (I.) The appearance of the flame in the furnace was indicative of low temperature, having that dull, yellowish appearance characteristic of flame laden with vapor, and of low temperature. Should this furnace ever be worked with an air supply less than is usual with coals per hour and per square foot of grate, the temperature of its gases would be higher. (J.) Were it possible to reduce the supply to that which is considered the minimum for coal, the temperature of furnace would rise about 200° above the figure just given, and that of the chimney would become 100° higher. I presume that these last values may be too high, and I am of the opinion that the first-given values may be somewhat too low; but, whichever may be most accurate, the fact intended to be illustrated, that the conditions are far different from those of ordinary practice, is well indicated, and the no less important difference between the conditions observable in the two examples of tan-burning furnaces is equally well seen. (K.) One burned its fuel in a furnace of comparatively high temperature, and with barely enough air to

secure perfect combustion. Thorough intermixture of gases and consequent perfect combustion, notwithstanding the small supply of air, was insured by the high temperature of furnace, by the comparatively slow movement of the gases through the furnace and flues, and by the special arrangement of mixing chambers. The other furnace was worked with an excessive air supply and consequent low temperature of furnace and of gaseous products of combustion. The larger volume of air and gases passing through the furnace and their low temperature prevented the thorough utilization of heat, as well as the perfect combustion necessary to its generation. One furnace is designed and operated in accordance with every acknowledged law of engineering practice and with scientific principles, while the other is built and worked in far less perfect accordance with them. The one develops so high a temperature that even its comparatively large boiler surface barely takes it up, while a small proportion of boiler surface removes the heat from the gases issuing from the other. Under such widely different conditions I cannot suppose that any formula of the construction of that quoted can apply to both. I have stated that even were Rankine's formula applicable to this exceptional practice, it does not follow that the extension of the heating surface over the Crockett furnace to a proportion similar to that adopted in the Thompson, would be found to give the anticipated benefit. During my trial of the Crockett furnace the steam never rose above the pressure there intended to be the upper limit, only once reaching 60 lbs. pressure, and the record oftener indicated 45 lbs. than any other pressure. The mean pressure was but 50.4 lbs. At the Thompson furnace the steam ranged from 60 up to 77 lbs., the average for the day being 71.4. The mean pressure was 16 per cent. below the maximum in the Crockett, and only 7 per cent. below the maximum in the Thompson furnace, although at the latter the dampers were partially closed during the greater part of the time. This indicates that, in the former, the draft was insufficient, and even if it were theoretically attainable, the anticipated efficiency is practically beyond reach, and were such improvement predicted by the formula it could not actually be secured. This can also be shown by a very simple method of deduction from data already given. I find the efficiency of the Crockett furnace to be somewhat higher than is given by the defendants in the paper which I am here examining, and I have stated it to have been at my trial of that furnace 0.48. To secure an increase of its efficiency to 0.64, that of the Thompson furnace, it would be necessary to decrease the temperature of the gases delivered to the chimney to such an extent as to reduce the heat there carried off in the proportion of 52 to 36. But this would reduce their temperature to about 145° F. Or, if the furnace can at any time work with the minimum air supply already stated as probably below the actual amount, the temperature of chimney flue would fall to somewhere near 160° F. Were the chimney gases even as hot as the temperature observed at the Thompson furnace, 554° F., the reduction required would bring it down to

160° F., to one-fourth of that given on authority of Rankine as proper. To exhibit still more strikingly the fallacy of this attempted application of the formula, it need only be remarked that the temperature of the boilers here was 300° F. The deduction which follows is evidently that no amount of boiler, no extension of heating surface, could in the Crockett furnace secure the efficiency actually attained in the Thompson. The whole matter of comparison of these furnaces may be summed up, perhaps, in the simple statement
353 that the one furnace produces so much higher temperature of gases, with similar fuel, than the other, that it needs an unusual proportion of heating surface to take it up properly, while the second has so low a temperature of furnace that no extension of heating surface can give it high efficiency. It is to be noted that the correspondence in Rankine's formula is traced in his illustrations through a set of experiments in which he begins with ordinary practice and ranges up into locomotive practice, of which violent draft and high temperature of chimney flue are distinguishing features. D. K. Clarke states in his "Recent Practice in the Locomotive Engine," (London, 1860,) page 22, that "it is well known that, in engines doing heavy duty, the temperature of the gases after having traversed the entire lengths of the tubes is frequently above 800°," and he also remarks, on the same page, that "the smoke boxes and chimneys are occasionally made red hot." In all of these cases of extremely rapid flow of hot gases through the flues, the effect is to equalize the value of heating surface, making that furthest removed from the fire comparatively useful. On the contrary, the more intense the heat of the gases, and the more slowly they flow, the less the value of extended heating surface. As Clarke states, page 23, "the more intense the combustion the less is the required run." The formula is most satisfactorily applicable, therefore, where difference in the mean value of heating surface does not seriously affect results, and where the mean value is not far removed from the extreme values. In the two cases to which it is sought to apply this formula circumstances favor remarkably the proportions adopted for each, while the mean value of heating surface differs to an unusual extent. At the Thompson furnace intensity of combustion and of heat, together with a moderate rate of flow, combine to make heating surface farthest from the fire comparatively valueless. Its reduction would have a far less important effect than at the Crockett furnace, where low temperatures and more rapid flow make all portions of the heating surface of more nearly equal value; and yet, in the latter case, to extend it would be to accept the other alternative of a dilemma by reducing the temperature of chimney flues when already below that needed for efficient draft. Since my first reply to the cross-interrogatory here considered, I have been able to examine with greater care the records of the trials of steam boilers referred to in paragraph 10 of my report as placed in evidence, which records are the only ones that I have been able to find in which the results are stated with the fullness and accuracy necessary

for the purposes of this comparison. (L.) I find here (see Transactions American Institute, 1871–72,) one case of wide divergence from ordinary practice in the proportion of heating furnace to fuel burned. It is that of the Blanchard boiler, in which $\frac{F}{S} = \frac{12.1}{51.8} = 0.23$. Comparing this with the Lowe boiler, as most nearly of the same type, but having a value of $\frac{F}{S} = \frac{97}{24.2} = 0.40$, we find their efficiency, by experiment, to have been 0.756 and 0.693. Rankine's formula would predict the values 0.822 and 0.764. In these two cases the areas of heating surface were not far from being similarly related to those of the two tan-burning furnaces. Yet, with practically the same kind of fire, the difference in performance was but 6.3 per cent., and even this small increase was only obtained by reducing the temperature of chimney to but little above the boiling point of water—to 223° Fah.—and by entire dependence upon mechanical draft, with its independent mechanism and its increased wear and tear. (M.) This should all be charged against the added efficiency. This is an excellent practical illustration of what I have supposed might take place with the Crockett furnace were the heating surface of its boilers similarly extended. Comparing other examples of the same trials, it is important to observe that with precisely the the same fuel, with the same temperature of chimney and of furnace gases, and about the same resulting efficiency, the Root and the Lowe boilers nevertheless have values of $\frac{F}{S}$ differing ten per cent., the former giving a value of 0.36 and the latter 0.40. The one has a tenth more heating surface in proportion to grate than the other, yet the actual difference of efficiencies is shown by experiment to be but between one and two per cent.; the figures were 0.709 and 0.693. Finally, comparing the Root and the Allen boilers, from the same set of tests, I find the one to have a value of $\frac{F}{S}$ one-third higher than the other—0.48 and 0.36—yet the difference of efficiency was practically nothing. The determination by experiment gives 0.709 and 0.707; the difference (0.002) is probably considerably within the limit of errors of observation. Supposing the difference in method of burning fuel which has been shown to exist at the two wet-tan burning furnaces to produce no effect upon relative efficiency, and judging by comparison with the most nearly similar of the above actual cases of ordinary practice, where, with quite similar relative proportions the
354 difference was but 6 per cent., we should expect a difference in proportion of heating surface in these two cases of tan burning

to produce a somewhat similar effect. But since the circumstances already detailed, by reducing the mean value of the larger extent of the heating surface at the more efficient furnace, and by correspondingly augmenting the value of the other, produce the effect of diminishing this difference due to reduction of heating surface, the actual value of this excess of surface would be below 6 per cent. The second pair of examples indicate that two boilers may vary in their proportions so as to make the ratio $\frac{F}{S}$ differ by 10 per cent. and yet have the same efficiency within 1.6 per cent. The deduction to be derived from the last two compared is that two boilers burning the same fuel, under the same conditions and by the same method, may differ in proportions of heating surface to fuel consumed to the extent of one-third and yet have precisely the same efficiency. The conclusion, from the whole investigation, is, in my opinion, that were the difference in extent of heating surface to which my attention has been called in Defendants' Exhibit No. 1 of October 16, 1874, the only difference affecting the resultant efficiency, the value for the Thompson furnace might be reduced slightly by making the proportion of boilers as low as in the competing case; but since great variations are shown to produce in the cases above very little, and, sometimes, no real effect, it remains quite uncertain whether the efficiency would be practically affected in this case. But when it is remembered that the temperature of furnace is widely different in these two cases of tan burning, and that in both cases the gases escape at a temperature lower than is considered requisite for draft, it becomes quite evident not only that the relative efficiencies recorded in the trial are not due to this difference of boilers, but that this difference has very little practical effect. But were this effect important, I conceive that the relative values of the Thompson and Crockett furnaces, as heat-producing apparatus, would not be different essentially from those determined by trial, as I have given them. The distinction between these furnaces is not that the one secures perfect combustion more thoroughly than the other, and thus develops a greater *quantity* of heat than any other. The difference in this respect, which I have noted, does not, in my opinion, account for the great difference in efficiency recorded. The combustion in both furnaces is practically and sufficiently complete. The appearance of smoke at Sparrowbush, while indicating some loss, did not seem to me to give evidence that that loss was serious. The large excess of air passing through the furnace would insure that no great loss could occur. Probably *no* loss could take place were not this excessive supply sent into the furnace at times in large volumes, which do not thoroughly mingle with and consume the combustible gases on the way to the stack. At Binghamton the gases from carbonaceous combustion in the ash pit, mingled with an excess of air, which is ultimately needed above the grate and in the mixing chamber, and the products of combustion from the ash pit, and the furnace itself, with the air thus supplied, and with the pro-

ducts of distillation, as described by Thompson himself, "mix, mingle and consume each other on their way to the object to be heated and to the stack," so perfectly that the loss is, as stated already, very slight, and probably too small in amount to be measured. The really important distinction, and that which produces the difference in efficiency, is that the one evolves the heat of combustion of the fuel at a temperature far above that of the boiler, and thus makes it largely available; while the other, liberating it at a temperature more nearly approximating to the lower limit—diffusing it through a large volume of gas instead of concentrating it—puts it under such conditions that a much smaller portion is available. The proper method of comparing these two methods of developing heat from the same kind of fuel, where extreme accuracy is desired, is evidently, therefore, to attach to each furnace so much boiler as shall, in each case, just reduce the escaping gases to the same temperature, which temperature is that needed for effective draft. In my judgment, very nearly such conditions, by a fortunate coincidence, existed at the trials reported by me. I therefore consider that the results obtained illustrate very accurately the relative economical merits of the two devices. The error in which this attempted misapplication of Rankine's formula has its origin is, I presume, partly in the misconception which I have discussed here at considerable length, and partly in an error of reckoning in the value of F, the water mingled with the fuel, instead of simply reckoning the carbon. Using proper values, we obtain, for F, 5.3 for the Crockett and 1.38 for the Thompson furnace. The values of S are $14\frac{1}{2}$ and $8\frac{1}{2}$, while in ordinary practice they range from 25 to 30. The values of $\frac{F}{S}$ are 0.36 and 0.13. The efficiencies deduced from these values are 0.776 and 0.859. The latter, it is to be noted, is almost precisely the value of the absolute efficiency—including evaporation of hygroscopic water—obtained by experiment. This is as it should be, since the mean temperature of furnace is not so far from ordinary practice as in the other furnace. The difference between the two values just stated, 0.083, eight per cent., is that which would be due to difference of heating surface were the formula precisely adapted to the case. The wide difference between the value for the Crockett furnace, 0.776, and that obtained by trial, 0.66, exhibits the effect of the low temperature of furnace to which I have called attention, and a cause of the inapplicability of the formula. The case, in my opinion, stands as before, and the results of the trials, as reported, represent the relative efficiencies of the two furnaces with a closely approximate and practically satisfactory degree of accuracy.

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Q. Do you offer the paper you have just read as an answer to the last question put you in the last examination here, and remaining unanswered; it is the question beginning "please calculate, &c.?"

A. I do not.

Q. Is it offered in answer to any, and if so, to what question or questions hertofore asked you?

A. It is offered as an amendment to the reply to the first question of last cross-examination, and to those succeeding questions which bear on the temperature of furnace gases, October 23d.

(Defendants' counsel objects to the statement as an argument rather than an answer, because throughout it brings in extraneous and irrelevant matters, and attempts to establish points beyond a range not appropriate to the questions referred. Objection overruled and exception taken.

Defendants' counsel also objects particularly, as irrelevant and argumentative, to the parts included between the capital letters A and B in the statement. Objection overruled and exception taken.

Defendants' counsel also objects to the part between B and C, for the same reasons last mentioned. Objection overruled and exception taken.

Defendants' counsel also objects to the part between D and E, for the same reasons. Objection overruled and exception taken.

He also objects to the part between E and F, for the same reasons. Objection overruled and exception taken.

Defendants' counsel also objects to the part between F and G, for the same reasons. Objection overruled and exception taken.

Defendants' counsel also objects to the part between G and H, for the same reasons. Objection overruled and exception taken.

He also objects to the parts between I and J, for the same reasons. Objection overruled and exception taken.

He also objects to the part between J and K, for the same reasons. Objection overruled and exception taken.

He also objects to the part from L to M, for the same reasons. Objection overruled and exception taken.)

Q. Will you now answer the last question put to you on the last day of your cross-examination here, and as yet unanswered?

A. I make the temperature theoretically obtainable under such conditions about 2400° F.

Q Upon what authority or writer do you rely to sustain so high a temperature as that?

A. Upon the authority of all writers upon the subject that I have consulted, including Rankine, Box, and Watts; Rankine gives the available heat from a pound of carbon at 14,500 thermal units; the heat here available is that due to the carbon contained within the fuel, and amounts to $(14{,}500 \times 0.50)\ 0.41 = 2{,}972$ 5-10 thermal units. From this is deducted the latent heat due 59-100 of a pound of water = 570 3-10. The specific heat of the resulting mixture is 0.291; the number of thermal units per pound of gas 694.03; the elevation of temperature becomes 2,836°, or approximately 2,400°.

Q. At what pressure is the steam or vapor of gas resulting from combustion?

A. Approximately atmospheric.

Q. Do you now find yourself able to state, and if so, state what

was the average heat of the furnace at Binghamton during your experiments?

A. The average at Binghamton during my experiments, as determined from the recorded temperature of chimney flue, was something over 2,200°.

Q. Do you mean by flue the passage beyond the boiler into the chimney?

A. Yes.

Q. How did you measure the heat at that point?

A. As stated in my report of trial.

Q. What did you assume or think to be the hottest point in that furnace?

A. I should expect the temperature to be approximately the same—a maximum—between the point at which the gases leave the furnace and the point at which they strike the boiler.

Q. Now what fact of science or what fact tested by your experiments enables you to say that the gases would be hotter at the point last indicated than the heat of the burning tan?

A. At a space between the point where flame is formed and the passage into the mixing chamber—omitting all theory—the opinion is sustained by observation.

Q. Is the observation you refer to other than that of the eye as you looked in?

A. It is not.

Q. You have referred in your statement to-day to the fact of melting grate bars under certain circumstances. Is it not true that such fires as you refer to are ordinarily hotter at the point where the grate bars are melted than anywhere else in the furnace?

A. I think not.

356 Q. Is it not so in the case of an anthracite coal fire?

A. I think not.

Q. Do you think that in an anthracite coal fire, in a furnace in use, the process of mixing gases goes on as is claimed in the Thompson furnace at any point?

A. I think not.

Q. Your attention is called to the fact that the pressure of steam was as great in the experiment at that furnace by Professor Chandler already referred to as by your experiment. Does not that indicate as high a degree of heat as in your experiment?

A. I do not see that it does.

Q. Have you read over his examination as printed in this case?

A. I have not.

Q. When you take into account the capacity, attainments, and character of that gentleman, and the fact that the consumption of fuel and the pressure on the boiler were substantially the same in his experiment as in your experiment; and that he tried by actually introducing zinc, silver, and copper into that furnace at the edge of the vertical flue, which he said appeared to him to be the hottest point, and that while it melted the zinc, which he says fuses at 793°, it did

not melt the silver, which he says fuses at a temperature of from 1,773° to 1,830°, or the copper which he states authority for fusing at 1,996°; and when you take into account that you did not make this test by introducing metals, which test you have stated might have been made as a very common way of testing furnaces; and when you take into account that your estimate of heat has now been stated by you to be substantially one of observation and deduction from your test of the heat that passed into the chimney, will you state upon scientific principles any good reason why this test is not a more reliable one than yours of the heat of the Binghamton furnace, and, also, why you stopped short of making the test which you have stated to be a common way of testing temperature?

(Objected to by complainant's counsel on the ground that the testimony of Professor Chandler does not bear out the facts assumed by the question, and on the ground that the question has already been fully answered by the witness. Objection overruled and exception taken.)

A. I cannot take into account what is assumed to be the fact in the question, that the furnaces were working substantially alike at the trial of which I have given a record and at Professor Chandler's inspection, since I have no knowledge of the condition of those furnaces on the last-named occasion; I can only judge by a casual glance at Professor Chandler's testimony that those conditions were quite different; in my own case the fires were working well, and the attendants were doing their best, but I have no evidence that such was the condition of things at Professor Chandler's inspection; the test of temperature made by Professor Chandler is a common method, and the results, so far as it gives results, I am indisposed to criticise. The fact that silver or copper were not melted would indicate that, at the time and in the place at which these metals were deposited, the temperature had not attained the figures given as the melting points; I cannot see that there is any evidence to indicate that that temperature was not exceeded in my own experiments; I did not myself make this test of temperature simply because I acquired all the facts which I, at the time, thought would be required for my purpose in determining the relative efficiency of the two furnaces, and because I did not at the time think of this matter as at all important; these estimates of temperature are all approximate; even the temperature given as the melting point of the metals silver and copper is above the point at which pyrometers are regarded by engineers as reliable in their indications.

Q. What conditions do you refer to as different in the case of Professor Chandler's experiment from what they were in your experiment, and in what respect different?

A. Referring to Professor Chandler's testimony, page 651, folio 1,948, I find the statement: "I do not believe that the limited combustion, in the ash pit, of the small amount of fuel that finds its way through the grate bars plays any important part in the action of the furnace." My own observation has led me to believe that this ash-pit

fire as I saw it plays a very important part in producing efficiency of furnace; I therefore conclude that Prof. Chandler found the ash-pit fires in quite a different condition, at his inspection, from that in which I found them during my trial, and that, if this were the case, the furnaces as he saw them were not doing as good work as when I saw them.

Q. Do you dispute the correctness of the melting point of silver as given by Prof. Chandler at page 645, folios 1,931 and 1,932 of his testimony? If so, state your view of its melting point.

A. I do not dispute these statements.

Q. Now if you had inserted silver into the furnace at Binghamton, and had kept it there a reasonable length of time to take the full effect of the heat of the furnace, and it did not melt, would you not have accepted that result as conclusive, notwithstanding all your statements and figures obtained by the means indicated in your statement, that the point of the furnace where that silver was was not at a higher point of temperature than the melting point of silver?

A. Most certainly.

357 Q. Do you not now consider the degree of heat developed in the furnace at Binghamton as material, and also as affecting the character generally of the estimates in your statements?

A. I consider it material as affecting the theory of the furnace, but not as affecting any of the practical and important results embodied in my report of my trials.

Q. If the temperature of the Binghamton furnace were shown to be not higher than that of the Crockett furnace, would you still claim that the efficiency of the Binghamton furnace was as much higher than the Crockett furnace as you have stated?

A. I think it would modify my views in a very important degree.

Q. Would it not modify them just in proportion as the heat of the Binghamton furnace might be shown to be lower than what you have estimated it to be? If not, why not?

A. It would so change my views of the theory of the furnace; the results of my determination of evaporative power being simple facts, it could not modify them.

Q. Supposing it should be proved that the heat of the Binghamton furnace was no greater than that of the Crockett furnace, then, in view of your last answer, would it not appear that the greater relative efficiency of the two was dependent on the boiler or on the manner in which the ratio of heat was utilized instead of the manner in which the heat was developed?

A. It would show that dependence to a greater extent than I have heretofore supposed.

Q. Would it not show if the heat developed in different furnaces from the same fuel was equal, but the amount of water evaporated to heat produced was different, that the difference depended on the boilers and not on the furnaces?

A. The only circumstance which I could think would modify the results in the supposed case would be the relative volume of gases

issuing from the two furnaces; I can imagine the conditions supposed existing at the same time with the different volume of furnace gases; this different volume of furnace gas would have an effect on boiler efficiency, which has been described in my previous answers.

Q. Now you are referred to page 650, folios 1,944 and 1,945, to question 16, and the answer given by Professor Chandler, and you are asked if you agree in view with him?

A. I do not think the professor is precisely right; the answer referred to reads as follows: "A greater amount of heat, and consequently a higher temperature, would be produced just in proportion to the saving of that heat which is lost vaporizing the water in the wet tan and raising it to the temperature of the furnace." The real state of the case, as I understand it, is that an amount of heat is lost which is not that due to vaporizing of the water in the wet tan and raising it to the temperature of the *furnace*, but the actual loss which occurs by the evaporation of the water and raising it to the temperature of the *chimney* only; the amount of heat accepted by vapor of water between the temperatures of chimney and of furnace is absorbed by the boiler; the loss of temperature would be as stated by Professor Chandler; the loss of heat would be as I have stated it.

Q. Are you willing to join in an experiment which shall test the relative heat of the Thompson furnace and the Crockett or Sparrowbush furnace, by the application of metals to the fire chamber, which, according to your rule, would be absolute?

(Objected to and excluded.)

Q. Assuming the fuel to be burned to be either wet tan, like that consumed in those tests, or dry tan, is there not a proper ratio of the amount of air to the amount of fuel consumed per minute, disclosed by scientific experiments, as adapted to producing the most efficient and economical results?

A. There is.

Q. Well, in your opinion, in respect to the Thompson furnace, was there too great or too small a proportion of air introduced to secure such results?

A. I am of the opinion that the amount admitted was very exactly that best adapted to secure the best results.

Q. Answer the same question considered in reference to the Sparrowbush furnace.

A. It is my opinion that the quantity of air supplied was far greater in amount than is required to produce the most economical results.

Q. In your statement to-day you have in substance declared that the difference between those furnaces is not that one secures more combustion than the other, but that the one produces a much higher temperature of gases with similar fuel than the other; that it needs an unusual proportion of heating surface to take it up properly, while the second has so low a temperature of surface that no extension of heating surface can give it high efficiency. Does not that important distinction mark the greater efficiency of the Thompson furnace,

according to your view, and turn upon the fact that the Sparrowbush furnace admitted a too great amount of air?

A. Not wholly, but largely it does.

Q. What is the other difference?

A. The other point is the rapidity of drying insured by mechanical arrangement in the Thompson furnace, which feature is not prominent in the Crockett. I am now speaking of general efficiency, and not purely of economy of fuel; this latter difference aids in securing the former.

Q. Now, is the indication of an excessive amount of air the
358 most important cause in determining different results, in your estimation?

A. Both are essential; I cannot say one is more important than the other.

Q. State the rule in determining the proper amount of air to combustion and the manner of consumption of such fuel as you had in those tests.

A. The rule is to secure the least amount of air that is shown experimentally and practically to supply the fuel with oxygen required for combustion, avoiding on the one hand an excess that shall cool the gases down, and on the other a deficiency that shall cause the formation of carbonic oxide.

Q. Now, was the ratio too much above that needed to supply the fuel with oxygen required for consumption? Was it in excess, in your opinion, at Sparrowbush?

A. I have given the amounts in the statement read this morning; I judge it to have been three or four times the amount theoretically required.

Q. Did you make any experiments there of trying the effect of admitting a less proportion of air?

A. I did not.

Q. When an amount of air is admitted to such burning fuel as gives an amount of oxygen thus greatly in excess of the amount required for combustion, what becomes of the excess of that oxygen and what purpose, if any, does it serve?

A. It passes off uselessly and subserves no good purpose.

Q. Is there not a certain fixed amount of oxygen with such fuel for its gases while taken in combustion with itself or with themselves in process of combustion under some chemical law, and by which law, also, the excess of oxygen introduced will be left with combustion or chemical combination and allowed to pass off in the draft of the chimney?

A. There is.

Q. Then if, as you say, this excessive amount of oxygen does not enter into combination in such a furnace as that at Sparrowbush, what, in your view, is the need of introducing it at all?

A. Its introduction is objectionable, but is compelled by the construction of the furnace and its method of operation.

Q. What part of the construction of the furnace do you refer to?

A. To the open ash pit and to the frequently opened furnace doors.

Q. To anything else?

A. To the fire as in operation and to the method of firing.

Q. Did I understand you right in assuming that you mean that this excessive introduction of air and oxygen serves no really useful purpose in the Crockett furnace, but is only a matter which usually takes place in your view from the construction or mode of feeding the furnace?

A. That is my view.

Q. Now, then, according to this view of the matter, if you were to so reduce the aperture for the admission of air into the ash pit that only the proper amount, according to the rule you have laid down, would be there introduced, and if you were to feed by a method that introduced no more air, or no more air than is introduced by the manner of feeding the Binghamton furnace, why should not the Crockett furnace give as good results and as great efficiency from the same amount of fuel as the Thompson furnace?

A. Because the other radical differences of construction and operation would remain.

Q. State concisely the other radical differences you refer to.

A. A lack of the deep ash-pit fire, of the fire-brick grates, and of a special provision for a thorough intermixture of the gases.

Q. How does a special provision for a thorough intermixture of the gases appear to be material in view of your statement made today, that the distinction between those furnaces is not "that one secures a more perfect combustion than the other, and thus develops a greater quantity of heat than the other"?

A. That statement was made in reference to the actual case, and not to the case as now modified. In the actual case this thorough intermixture is secured by a provision for the great excess of air there referred to in connection with the Crockett furnace, while the special provision referred to secures the same object in Thompson's furnace. Here, in the supposed case, the restriction of the amount of air supplied in the Crockett furnace would lead, in my opinion, to imperfect combustion in the formation of carbonic oxide before the theoretical limits were approached, since by the method of firing in this furnace the cold air passes through the furnace in places in isolated streams. To obtain identical results it would be necessary to make all conditions identical, since I conceive all of the conditions observed in the Thompson furnace to be essential to the attainment of efficiency by this restriction of air supply.

Q. At what place in the Thompson furnace and at what place in the Sparrowbush furnace, respectively, do you consider the mixture you refer to to take place?

A. In the Thompson furnace I consider the mixture as taking place throughout the fire chamber, and as probably completed in the mixing chamber. In the Crockett furnace I imagine it to take

place partly in the furnace itself and partly in the flues on its way to the stack.

Q. Now, if your knowledge or information on this subject of mixing in either furnace is anything more than mere guess or speculation, then state with the utmost brevity what more it is and what it is?

A. It is derived from careful observation from the furnaces
359 at work, and from a comparison of results obtained by experiments.

Q. Did you in either see any different kinds of gases or products of combustion mixing; if so, state the color of each and where you saw them mixing, and what that term "mixing," as presented to your eye, means?

A. I saw the products of combustion and the gases above the fuel in each case; at the Crockett furnace the irregular appearance of the flames above the fuel, and at the Binghamton furnace the general glow of flame that pervaded the whole interior; these are the two indications to which I have referred. The color of the Crockett was, as I have already stated, that consistent with the low temperature—a dull, yellowish flame. [Answer objected to as irresponsive to the question.] At the Binghamton furnace the colors were those demonstrated as those of white heat, or more nearly those of white heat.

Q. Was the color at Binghamton uniformly that of white heat?

A. I do not now remember to have noted particularly.

Q. If you did not note particularly whether the color was uniformly that of white heat, upon what fact of observation can you state that you saw any gases mixing or beginning to mix?

A. I do not remember to have made such a statement.

Q. If, then, you saw nothing of any mixture of gases at Binghamton, why does it not appear, as far as any results of your experiments, or anything you saw or learned, that all that has been said about mixture of gases in that furnace or in the mixing chamber is pure guess and speculation?

A. For the reasons which I have already given at length and in detail.

Q. If in the most effective use of a furnace you get a heat of 2,264° from wet fuel, 59 per cent. of water, what, according to the teaching of science or of experiment, would be the heat of that furnace if you add 50 per cent. to the air used in such most effective experiment?

A. I will consider the question. [A.]

Q. What would be the equivalent evaporation of pounds of water to a pound of fuel for a range of temperature between 2,264° and 544° for a furnace and 544° for a chimney?

A. I will consider this question. [B.]

Q. What would be the equivalent of evaporation under the same conditions, except that the range of temperature was between 1,715° and 544°?

A. I will consider this also. [C.]

Q. Please give the units of heat of wood of ordinary dryness containing about 20 per cent. of hygroscopic water.

A. This, also, I will consider. [D.]

Q. Give the units of heat per pound of fuel in a vegetable matter containing 59 per cent. of hygroscopic water.

A. I will determine this also. [E.]

Q. You give the theoretical temperature of a vegetable fuel containing 50 per cent. of water as about 2,386° F. Now, how can you ascribe to such a vegetable fuel such a temperature in a Thompson furnace at 3,209° F.?

A. I will answer this question at the next session. [F.]

(The professor answers the questions marked A, B, C, D, E, and F as follows:)

To question A he answers thus: 1,869°. This is obtained on the basis of the fuel containing 59 per cent. of water, 41 per cent. wood, and using 50 per cent. more than the theoretical quantity of required air.

To question B he answers: The equivalent evaporation per pound of tan is 1.79, or per pound of wood in the fuel, 4.36.

To question C he answers as follows: It would be 1.22 per pound of tan, or 2.97 per pound of ligneous material in the tan.

To question D he replies: Box gives (page 46) 5,265°; Morin and Tresca give 5,600°; Trowbridge (page 90) gives 6,400°; Watt's Dictionary of Chemistry gives "average dry wood 6,385°;" Rankine (page 278) gives 5,600; (page 278) "dried wood 7,242°;" and Trowbridge gives (page 90) "dry wood 7,200°."

To question E he answers as follows: This I have given already at 2,972.5 thermal units, taking the wood as half carbon.

To question F he answers: I do not.

Q. What temperature have you ascribed to the Thompson furnace, and what temperature do you now claim it reached in your experiment? Please answer in figures.

A. I have stated that the Thompson furnace would acquire a temperature of 2,460° as the average deduced from my experiment, on the supposition that the fuel lost no water in handling, but entered the furnace with 59 per cent. There is, however, some loss in handling the fuel, the amount of which I have no means of determining accurately.

Q. Do you mean to be understood as swearing, as a matter of fact within your knowledge, that the Thompson furnace in that experiment reached 2,460° of heat?

A. Certainly not.

Q. Can you swear that to your knowledge that furnace in that experiment reached 2,000° of heat?

A. I do not.

Re-direct examination:

Q. What is the usual mode adopted by engineers in determining the heating powers of a furnace?

A. By measuring the amount of heat utilized by the furnace; for example, as in the present case, by measuring the heat carried away by water, as was done on my trials.

Q. Is it regarded as a satisfactory method of determining the heating powers of furnaces by the employment of metals in
360 such a way as has been referred to on your cross-examination?

A. I think not.

Q. What is the best method of determining the heat in a furnace—by means of a pyrometer or the use of metals?

A. By the use of a pyrometer.

Q. Why is it not a satisfactory method of determining the heat of furnaces by the use of metals in the manner indicated?

A. Because the melting point of metal simply determines one point on the thermometric scale, and the melting points of the several metals simply determine points separated by considerable intervals; the fact that under certain conditions one metal melts, and another does not, simply gives a range within which the temperature of the medium surrounding the metals exists; it does not tell the temperature of that medium.

Q. Was the tan taken by you and dried in this case, in the manner you have stated, a fair representative of wood of ordinary dryness, or of "average dried wood," such as Watts refers to when he says, "average dry wood, 6,385 thermal units"?

A. When dried it was of more than ordinary dryness.

Q. When you closed the experiment at Binghamton, what did you do with the tan in the furnace—how did you leave it?

A. When I left it the last portion of tan had been crowded into the feed holes, and I left the men stamping it in.

Q. Was the furnace precisely in the same condition at the end as at the beginning of the trial?

A. It was, so far as I know, except as I have just stated, it was left crowded with fuel.

Q. As to the furnace at Sparrowbush?

A. At Sparrowbush I left the furnace, as nearly as I could judge, in precisely the condition in which I found it; the last portion of the fuel had just been thrown in through the furnace doors.

Q. What was your object in endeavoring to ascertain how much power was required at Binghamton and at Sparrowbush, at your first visits to those places?

A. I investigated that matter thinking it possible that I might form some opinion of the quantity of steam used, and of the relative efficiency of the furnaces without proceeding to make a trial.

Q. What was the height of the chimneys at the two places, and if of different heights, what difference would this difference of height make in your results?

A. One was 70 and the other 90 feet in height; the damper was partially closed during the greater part of my trial in the taller

chimney, and I am of the opinion that the two chimneys were thus rendered practically of very nearly equal value.

Q. What is the difference between the condition of steam as blown off from a steam whistle or safety valve, and the condition of steam at the top of a chimney?

A. Steam blown out from a whistle or safety valve of a steam boiler issuing from under high pressure expands suddenly, cooling by its expansion approximately to atmospheric pressure, and the slightest loss of temperature or diffusion with the air makes it visible; steam issuing from the top of a chimney, as at these trials, is diffused already through the volume of hot gases; it does not expand, and retains its temperature and its invisibility until the whole mass of gas has cooled to a temperature of 212°; it therefore follows that steam issuing from a safety valve is seen at once, while that rising from a chimney in the midst of hot gases, as at Binghamton, frequently remains invisible until so thoroughly diffused into the atmosphere that it cannot be seen even after condensation, and does not appear at all.

Q. Then does the presence of steam at the top of a chimney offer any indication of the temperature of escaping gases?

A. If the gases are escaping from the chimney at a temperature very much above the boiling point of water, the steam remains invisible, but if, in any case, it is seen, it is because the gases with which it is mingled are at a temperature approximating to the boiling point.

Q. Has the Thompson furnace any advantage over the Crockett furnace in the treatment of wet fuel before entering the furnace; if so, how does it bear on the temperature of the furnace?

A. It has an advantage; in the Thompson furnace the grate surface is widely extended, and above it is an area which amounts in this Thompson furnace of which I have made the trial to 250 or more square feet; the fuel may be spread on the top of this furnace, retaining the heat which might otherwise escape, and its non-conducting property can be thus rendered available in economizing that heat; a second advantage is, the heat which thus escapes into the tan is utilized in partly drying the fuel before it enters the furnace; the Crockett furnace, on the other hand, has a comparatively small area of top at a low temperature, and the method of feeding would compel, were this area utilized for drying the tan, a second handling of the fuel with a corresponding expense for labor; this difference would seem to have some effect; it is inherent in the construction and management of the two kinds of furnaces.

Q. Was the method of measuring the tan in the leach the best that could be adopted in general, and also in these particular cases?

A. I consider it to be the best, because in making a comparative test of efficiency the tan is found in the same condition in both cases only at the leach; again, in the leach the tan has been washed by a current of water flowing through it, which settles every
361 particle into place, arranging the mass so compactly and making it so uniform in density, that I should not expect to

be able to secure such perfect similarity and equal accuracy by any process of weighing or measuring which involved handling it.

Q. Suppose any error to exist in the measure as you made it, would it have any practical value, and if so, what side would be benefited by the error, and why?

A. I cannot say that an important error could arise in such comparison; it is a fact that the lower portion of the leach carrying the the superincumbent mass would be somewhat compressed, but if this produces any practical effect it would in this instance have told in favor of the Crockett furnace, since there only the lower half of the leach was used, and in measuring it would have a greater comparative amount of fuel given to it than it is actually credited with.

Q. Could a hole have been conveniently made in the feed pipe for the purpose of determining the temperature of the feed?

A. Not conveniently.

Q. Was it important to do this in order to show a correct result?

A. I do not think the result would have been appreciably changed.

Q. How did you obtain the temperature of the feed at Sparrowbush?

A. By catching water, where possible, as it leaked from the feed pipe on its way to the boiler, and by comparing the temperature of the feed pipe itself with the temperature of the heated water used in the experiments on priming.

Q. Has your determination of the amount of water in the fuel any reference to the time of draining?

A. None at all.

Q. Why were you not in the presence of the engine working the pump during the whole trial at Binghamton?

A. Because it was more important that I should be in presence of the furnace.

Q. How often did you visit the engine during the trial?

A. I do not know how many times; a great many, however; I watched it very carefully, and as often as I had opportunity.

Q. What precaution, if any, did you take against any error arising out of any irregularity in the action of the pump?

A. I compared carefully the times required, in several instances in which it was tested, for drawing the water from the tank; I visited the pump as frequently as possible to see that its valves were working properly, and that it was running at regular speed, and even when not at the pump, could hear its movement from outside the door, and knew that it was working as well.

Q. Why do not the rules of evidence referred to on your cross-examination apply to experiments treated as doubtful at Binghamton; state precisely how those experiments were performed?

A. The rules of evidence there referred to are applied to cases in which a datum is to be regarded sometimes as doubtful, and no other means exist of determining an approximate value; they apply to cases in which an endeavor is made by several observations to obtain precise values of a certain datum; in the present we have an

entirely different case; in determining the percentage of priming in that instance, steam was led into the vessel containing the water to be heated, as described in my report, and the temperature of the mass gradually rose until the temperature of 116° was reached; when the steam pipe was removed and it was found that the scale beam did not precisely balance, and that an addition of a small quantity of steam was still needed, the steam pipe was then returned by the attendant, who placed it in the vessel and allowed a sufficient quantity of steam to enter to cause the scale to balance; the temperature was then again taken, but the new reading was 124°; this datum was recorded and was made the basis of the first estimate; on after-consideration the lower figures 116° were taken for the reasons given in my report; it could not have been lower than this; the cause of the higher temperature actually recorded was subsequently concluded to have been the inadvertence of the attendant, in not inserting the steam pipe well below the surface of the mass of water, and thus only heating the surface layer, the temperature of which was taken by the thermometer; it is therefore certain that the priming at that experiment did not exceed the amount given in the estimate.

Q. Explain why the amount of priming at Binghamton should not be expected to exceed that at Sparrowbush, notwithstanding the greater amount of steam made?

A. The fact is readily accounted for by the greater amount of boiler; it is possible also that the steam may have been taken more regularly from the boiler. It was also taken from the boiler at one point by the steam pipe, and at another point by a safety valve.

Q. Why, all things considered, do you approve of a high chimney; is the efficiency of the furnace at Binghamton due in any respect to a high chimney?

A. I approve of a high chimney because if it gives too much draft it can be controlled; for the reasons already given, namely, the fact that the dampers were not kept wide open, I consider that the efficiency of the Binghamton furnace was not due to its high chimney.

Q. Did you see any dry fuel at Sparrowbush, and if so, what?

A. I saw piles of tan drying in the sun, and some wood.

362 Q. How many ovens of the Sparrowbush kind would it require to make the amounnt of steam produced at Weed's, using his three boilers, and how much wet tan would they consume in doing this?

A. They would need about a one-half larger furnace than that at Sparrowbush, and would burn one-third more fuel than now.

Q. In what respect, if any, is the manner of measuring tan, as described by you in section 8 of Exhibit No. 1, unscientific or inaccurate?

A. I do not consider it unscientific or inaccurate.

Q. Do you find any description in Thompson's reissued patent of feeding furnaces by a single fire chamber with alternation?

A. I do not.

Q. Could you adopt the process of alternate feeding in the Laporte and Thorndale furnaces as now constructed?

A. The furnaces do not seem to be constructed with that object, but I suppose I could find a way of doing it.

Q. Did you see wet tan in the furnace at Laporte, and did it appear to have been moved in the oven after it was fed through the feed holes on the top?

A. It appeared to me to have been moved.

Q. How did the furnace at Stevens differ, if at all, from the two-oven furnace?

A. By having no dividing wall.

Q. Look at drawing "Exhibit Wells, figure 1," on page 245 of defendants' exhibits, and state whether you find a mixing chamber at the rear of the oven such as is described by Thompson in his two patents—reissued patent March 31st, 1857, and patent of December 15th, 1857.

A. I do.

Q. Look at figure 2 of said exhibit, and state whether or not it shows such a furnace with three ovens as is described by Thompson in his said reissued patent of March 31st, 1857, and, if not, state in what respect it does not?

A. The drawing does not show whether there are three distinct ovens. It admits of management as three ovens, and in so far corresponds with the claim of the patent.

Q. Does or does not this exhibit describe the Stevens furnace you saw at Great Bend?

A. It is a similar furnace, except in the number of doors.

Q. Do not you understand the defendants to claim that wet tan containing between 55 and 60 per cent. of water can be efficiently and practically burned in such a furnace as is shown in Box by figure 4, following page 261?

A. That is my understanding.

Q. Does Box in his said treatise make any reference to any peculiar furnace, such as Thompson's, burning wet fuel?

A. Not to my knowledge.

Q. Are not all his remarks made in reference to well-known dry fuel furnaces?

A. They are, so far as I know.

Q. You have been challenged by defendants' counsel to refer to any respectable writer or authority on chemistry who sustains the views of Professor Silliman and Mr. Plumb as given in their testimony in this case; your attention is called to the opinions of Mr. Stadtmuller, Doctors Page and Gale, Mr. Cooper and Dr. Hayes, on pages 26, 31, 36, 44 and 45, in the pamphlet entitled "Bagasse Furnace Suit, &c.," read in evidence on the hearing of this case, and you are requested to state whether those gentlemen, or either of them, are respectable authorities on chemistry, and whether their opinions as therein given do not accord with with those expressed by Professor Silliman and Mr. Plumb?

A. They do indorse Professor Silliman and Mr. Plumb; two or three of those gentlemen I have supposed to be accomplished chemists.

Q. In the report of your trials, is there any one important datum taken by you on assumption?

A. To the best of my knowledge and belief there is not one.

Q. Is there any one datum in which any possible or probable existing error tells against the Crockett furnace?

A. In my opinion there is none.

Q. Why did you allow those things, if any, to go against the Thompson furnace?

A. I believe no errors exist in my results which are of appreciable value, and I allowed them, where they possibly might exist, to tell against the Thompson furnace simply because I wished to avoid the slightest possibility of making deductions which would tell unfairly against the Crockett furnace.

Q. Casting aside all metaphysical and purely theoretical considerations, the result of your own investigation and examinations and of other testimony indicates, does it not, that the Thompson furnace is 33 per cent. more efficient than the Crockett, even when, as you state, the Crockett infringes upon and derives some advantage from the principles of Thompson's patent?

A. I consider that to represent their relative efficiency.

Q. Did you see his two sets of furnaces at Sparrowbush?

A. I did.

Q. Judging by your own observation and information, what bearing has the fact that but one of those furnaces has been put in evidence by the defense in this case, and the other fact, as has been testified to, that no dry fuel is used in it, upon the third fact, as testified, that dried tan, green wood, dry wood and coal, have been used in that establishment in addition to wet tan?

(Defendants' counsel objects to this question: 1. As hearsay and argumentative. 2. As not calling for a scientific opinion. 3. As asking this witness to come in and help the counsel on the other side to complete a process of deductive reasoning from facts, most
363 of which are mere assumption. The answer to this question to be taken subject to the ruling of the master.)

A. The dry fuel must have been reserved for the other furnaces.

(Counsel for defense here moves to strike out the answer as mere inference.)

The comparison which I have made becomes simply a comparison of the efficiency of the two furnaces, and does not indicate what benefit is derived by the establishment at Sparrowbush from the use of dry fuel.

Q. Are the calculations of the furnace temperatures, as given in your evidence, intended to be mathematically correct, or are they approximate?

A. They are intended to be simply close approximations.

Q. Supposing them to be modified by a more precise determination, how would the relative standing of the two furnaces be affected, as determined by the trial, and how as to theoretical conditions, and what do you consider to be the established facts?

A. Such modifications of those calculations and estimates has not, so far as I can see, any important bearing on the question of the relative efficiency of the two furnaces as determined by me, and, although the absolute values of the figures might be slightly changed, I should not expect such change to produce any important change in the theory of the two furnaces; I consider it to be an established fact that a cord of wet tan, taken directly from the leach, evaporates 33 per cent. more water when burned in a Thompson furnace than an equal weight of wet tan from the leach when burned in a Crockett furnace; I consider it to be a fact that the temperature is very considerably higher in a Thompson than in a Crockett furnace; I consider it to be a fact that an attempt to secure greater economy in the Crockett furnace by the use of a greater area of heating surface would not produce the desired result; I consider it to be a fact that the absolute efficiency of a Thompson furnace is fairly represented by the figures given for that absolute efficiency.

Q. How would better boilers give a better result, if at all, at Sparrowbush, and would any other form of boiler be practically more economical?

A. Another form of boiler might reduce the amount of priming and give dryer steam, making it of more value than now; I do not think a change in the form of the boiler would produce greater economy in any other respect.

Re-cross examined:

Q. Referring to figure 1 of "Wells," to which your attention was called on this re-examination, do you not understand it to show a boiler which comes as far to the front as the rear end of the ash pit, and which shows a passage under the boiler, with straight parallel sides all round and nothing more, as to the shape of the communication between the furnace and the boiler surface?

A. I do.

Q. Where, then, does the mixing chamber you find begin and end?

A. The portion which I consider to be a mixing chamber is that portion of the passage for gases which is included between the two inclined lines shown in the section. The flue itself is also a substantial equivalent for a mixing chamber under the reissued patent of 1857.

Q. How much of the length of the flue, starting from the furnace, do you include in the mixing chamber?

A. The whole of the flue from the oven to the stack is included under that claim.

Q. When you say it is usual in measuring the heating power of a furnace to ascertain it through the evaporating power, do you mean

that it would be usual if the real object was to ascertain the temperature reached by the furnace itself, entirely irrespective of how much steam it would make in any given kind of a boiler?

A. In such a case the more usual way would be to use a pyrometer within the furnace.

Q. Would not the steam going out into the open air, whether from the pipe blowing off steam or from the chimney carrying out steam, be made visible by condensation whenever it passed into air below 212°?

A. It would not.

Q. Do you mean to be understood as indorsing the views of the gentlemen whose opinions are brought to your attention in this bagasse furnace case?

A. Certainly not.

Q. Can the plaintiffs' patent, so far as it involves scientific questions, be sustained in your opinion upon the theory both that water is a useful element of combustion and increases the efficiency of the furnace, and on the theory that it does not increase the efficiency of the furnace, but tends to put the fire out? Can the two theories stand together in support of the patent?

(Counsel for plaintiffs objects to the question as incompetent. Question ruled out, and exception taken.)

Q. What theory, in your opinion, would, if accepted, contribute most to the support of the patent?

(Same objection as before. Ruled ont, and exception taken.)

Q. Can you tell us whether the substitution of yourself for Professor Silliman as an expert in this case indicate a purpose to abandon the theory that fire can be made out of water, and to take up the theory that fire puts out water?

(Objected to. Ruled out, and exception taken.)

Testimony of George M. Rea.

GEORGE M. REA, called as a witness for the complainant, and being duly sworn, deposes and says as follows:

Question. What is your profession?

Answer. I am a lawyer by profession.

364 Q. Have you read the patents of Moses Thompson for burning wet fuel, dated March 31st, 1857, and Dec. 15, 1857?

A. I have read them.

Q. Have you seen furnaces in operation burning wet tan as described in those patents?

(Objected to, it not appearing that the witness is competent to give an opinion as to the construction of the furnaces described in the patent. Taken subject to objection.)

A. I have.

Q. About how many?

A. About thirteen or fourteen.

Q. Did you see those furnaces in operation?

A. They were nearly all in operation. Two of them, I believe, were not in operation.

Q. Burning wet tan?

A. Burning wet tan.

Q. Describe in a general way how those furnaces were built.

A. They were built with ovens—two, three, or four—about nine feet in length by four in breadth, with two feed holes each on the top, and ash pits about twelve inches in depth, and all the ovens entering into one general chamber in the rear.

Q. Had they fire-brick grates?

A. Yes; fire-brick grates.

Q. Where was the fire?

A. The fire was in the ovens, a considerable amount of it falling into the ash pits below.

Q. Did you ever see the furnaces of Swazey, Cooper & Co., at Sparrowbush; and if so, when did you see them?

A. I first saw them in the fall of 1870.

Q. Just state how they were situated when you saw them there; describe where they were.

A. At the tannery there were two furnaces fed in front, the heat passing directly in under the boilers over bridge walls at the front ends of the boilers or rear ends of the ovens, and as far as I can recollect and observed at the time the fire was made to hug the boilers by a shallow flue under the boilers.

Q. Any other bridge walls besides these?

A. No bridge walls except these.

Q. Any ash-pit fire?

A. No ash-pit fire.

Q. What kind of fuel were they using?

A. Dry and wet tan mingled; there was some wood lying there, but I do not recollect seeing them use it; this was at the upper furnace.

Q. Now describe the other furnace that you saw there.

A. At the lower furnace there was but one oven; in other respects it was similar to the one just described, the heat passing in under the boiler in a similar manner.

Q. Have you been there since, Mr. Rea?

A. I was there lately; Nov. 13th and 14th this year.

Q. What kind of fuel were they using in the lower furnace in 1870?

A. Some wet tan with some dry tan mingled in.

Q. You say you were there on the 13th and 14th of November this year?

A. Yes.

Q. Did you examine the furnaces in operation then?

A. I examined them then in operation.

Q. How was the furnace at the upper works built; was there any difference in their construction from the time you saw them previously?

A. It had been changed somewhat; there was under the boiler, about midway, a bridge wall beside the one in front; the one in front was about 15 inches from the top of the oven; there was one under each boiler, under the center of the boiler, about 8 inches from the boiler; it came up to within about 8 inches from the shell of the boiler.

Q. And the flue itself was about how deep?

A. Under the boiler it was abont 3 feet deep.

Q. What kind of fuel were they burning in the furnace?

A. They were burning wet tan exclusively.

Q. Any ash-pit fire?

A. There was quite a burning of the tan that fell through into the ash-pit—sufficient to make it quite light, both in the ash pit and on the bottom of it.

Q. What kind of grate bars had they?

A. They had iron grate bars about a quarter of an inch apart. In some places they were a little sprung by the heat, which made them a little wider here and there.

Q. Did you examine the lower furnace on those occasions?

A. I examined the lower furnace also.

Q. State if you found there any alteration?

A. I found there two ovens in operation, both discharging their heat under the boiler by holes, the holes being as near as I could judge 10 by 20 inches each. Each hole 10 inches one way by 20 inches another.

Q. And a flue under the boiler into which they were discharging these gases?

A. Yes.

Q. How deep was the flue under the boiler?

A. About three feet, with a bridge wall in the center. The space under the boiler was abont three feet from the bottom of the flue to the shell of the boiler, the same as at the other furnace, as well as I could judge. I could see into this latter one better than I could into the other.

Q. How near did this bridge wall come to the shell of the boiler?

A. About eight inches. There was some ash-pit fire, not as much as in the upper one, so that it made rather a scattering fire in the ash pit on the bottom.

Q. At the upper tannery, was the flue under the boiler a common flue, or were they separated?

A. I think they were separated, except that I was told there
365 was a little bit of space in common that did not amount to much just at the front of the boilers. I could not see into it, but a man told me of it; a wall separated the space under the boiler lengthwise.

Q. Did you go through the buildings at this tannery; any of them?

A. I went through the upper tannery and partly through the lower;

I saw two stoves up in the upper tannery; in the currying shop there were coal stoves.

Q. Did you see any dry fuel on the ground?

A. I saw a little lying here and there; it was outside of the upper building; there was a little dry tan with pieces of bark among it; I saw coal.

Q. About how much coal?

A. I could not judge very well; but, perhaps, about 50 or 60 tons; I saw a little wood.

Q. Whereabouts on the premises was this coal and wood?

A. The coal was lying in a place down by the canal, midway between the two furnaces, I should think; of wood I saw very little, but what I did see was lying in the tan yard, a part of it under the bark.

Q. Did you operate either of those furnaces yourself?

A. A man operated them both under my directions.

Q. How were they operated when you went there?

A. When I went there they were in full operation; they were throwing in wet tan during every few minutes, first into one hole and then into the other; the ash-pit doors were wide open.

Q. Did you watch them being operated for any length of time in that way?

A. Well, not long.

Q. Long enough to see how the fuel was burning?

A Yes; I looked to see how the fuel was burning; it was burning well at the time I arrived there; it was quite a brisk fire.

Q. Go on and state what you did in the way of directing the operation of either of those furnaces.

A. Well, at the upper tannery we banked the ash pits, instead of closing the doors, with wet tan up to within an inch, an inch and a half or two inches of the top, thus varying by the tan falling in the act of feeding, and the man roughly shoveling down the bank again without regard to the exact amount of opening; they fed the same still during the time it was banked, and the fire continued brisk, but the steam fell a little; the fire contined brisk all this time, and the glow of falling embers in the ash pit seemed rather more during this time as I looked through this narrow space—falling through rapidly while feeding, and the rest of the time regularly; upon unbanking the steam rose again a little; we banked half an hour; all the machinery was at work, the bark mill and all. I then went to the lower tannery; there we shut the doors of the ash pit, leaving an inch and a half open, and, instead of feeding each oven, one immediately in succession after the other, as before, we would wait a few minutes until the one last fed was pretty well going; I could not say how many minutes in difference there would be, as I have not noted it down here; under this operation the steam rose rather higher than when we first arrived there; when we first came there there was quite a brisk fire; we arrived at the lower tannery at 8 minutes to 11 o'clock, and closed at 12 o'clock—about an hour altogether. In

the afternoon of the same day I went again to the upper tannery; there we closed the ash-pit doors, leaving an inch open, and alternated the feeding in the same manner as we had done in the lower tannery; the fires continued brisk, and the steam, as near as I could judge, rose; the bark mill was off part of the time then.

Q. How long did this last operation go on?

A. From half-past 3 p. m. until 5 minutes to 5 p. m.; then the ash pit doors were shut entirely tight, and we left at 18 minutes past 5; the fires were burning very briskly at the time of closing the doors, and during this latter time, while the ash-pit doors were closed entirely, it did not appear to make any material difference in the steam.

Q. This was the first day you were there when those experiments were made?

A. Yes.

Q. Did you see the furnace on the following day?

A. On the next day I got to the upper tannery furnace at 6 a. m.

Q. Was it in operation then?

A. The furnace-man had just arrived, and had begun to scrape away the ashes from the ash pits, and had got them opened.

Q. Well, state what occurred there then.

A. After he had scraped away the tan he opened the furnace doors; first one and cleaned out that oven, first scraping the burning tan to one side; he scraped the baked ashes off the grate bars, and after thus cleaning on one side he scraped the embers over on the other side and cleaned off the other side of the grate bars, which were also clogged with baked ashes in the same way; he then threw in some wet tan to start with; then he did the same with the other furnace, and threw in some wet tan, and very shortly after, as soon as it commenced to burn, he threw a little more into the first cleaned, and so on until there were very good fires in both, and then went on feeding as he did the day before when I first arrived there; there was soon a good fire—in twenty minutes after the cleaning of the grates.

Q. When did they begin working the machinery?

A. At five minutes past 7 the machinery was set in motion.

Q. You left the furnace then?

A. Yes, we left the furnace about 15 minutes after 7.

366 Q. Did you go back there again, or was that the end of it?

A. That was the end of it; the first day I was there, there was a favorable wind from the northwest, and on the morning of the following day, when starting the fires, there was a very moderate wind from the east.

Q. You did not see the fire started at the lower tannery?

A. No, I did not; when I left there, there was a good fire, but I did not see it started.

Q. From your observation, when did the fire give out the most heat—under the process that you adopted of partially closing the ash-pit doors, or under the process that they adopted there?

A. The partial closing of the ash-pit doors and the alternate feeding improved the operation of the fires, but when we banked the first time and fed the usual way it seemed not to better the condition, and made it a little lower. We took off the bank and the steam ran up then from 50 to 52.

Cross-examination:

Q. Where do reside?

A. In the city of New York.

Q. Do you practice law?

A. I do not.

Q. Have you any business?

A. I have no business. My health has been in poor condition for some time, so I had to leave off practicing.

Q. Where did you practice?

A. In the office with Mr. Black.

Q. Were you his partner?

A. No, sir.

Q. When did you cease practicing?

A. Last June—the early part of June.

Q. When was your attention first called to this suit?

A. I believe it was in the fall of 1870, when I went up to Sparrowbush the first time.

Q. Was that the first time you knew about this tan-burning furnace?

A. Yes.

Q. What did you have to do with it since?

A. I was in office and not practicing law at that time. On that occasion I went up to Weed's furnace also, and since that time I have visited all the tan-burning furnaces of this description that I could find in Sullivan county. I think they were twelve.

Q. And search them out for Mr. Black?

A. Yes, and made minutes of them, took general measurements of them and general descriptions of them.

Q. How were you paid?

A. Well, I have not been paid yet. There is, of course, and understanding that I shall be paid when there is money sufficient to pay me out of the tanneries.

Q. Out of the litigation?

A. Not out of the litigation, but when we have collected from the infringers. I commenced suits and took a good deal of the office business on my shoulders, besides visiting those tanneries.

Q. You have that same relation now?

A. No, sir; I have no relation now; it ceased in June last, as I was not able to attend to business any more.

Q. Do you claim to be skilled in patent law as an expert?

A. Not more than you will observe from my examination of those furnaces; besides those furnaces, I never had anything to do with patent law.

Q. Were you ever examined as an expert in a patent case?

A. Never, except when I was examined in these cases.

Q. Do you claim to be a scientific expert?

A. Well, no, I cannot say that I do; in a general way I have some knowledge of a Thompson furnace.

Q. What scientific education have you?

A. The ordinary college education; I graduated at Princeton, N. J.

Q. Have you ever directed your attention to mechanical science?

A. No.

Q. About how far apart are those two furnaces at Sparrowbush?

A. I did not measure, but I should judge from 150 to 200 yards apart; I did not direct my attention to it; well, it might be from 100 to 150 yards.

Q. Do the two furnaces give heat to the same building or buildings?

A. To different buildings.

Q. What is the business carried on at the upper furnace?

A. That is the tannery and currying-room and bark grinding place.

Q. And what at the lower?

A. At the lower the rolling of leather goes on, and there is the heating-room; I did not observe everything in reference to that.

Q. When you speak of wall existing lengthwise under the boiler, do you refer to the upper or lower tannery or both?

A. To the upper tannery only.

Q. How many ash pits and how many boilers at the upper tannery?

A. Two.

Q. How many feed places are there to each of the fire chambers at the upper furnace?

A. One door to each.

Q. Is there any communication between the two fire chambers at the upper furnaces, or any communication between the parts in the space under the boilers formed by that separating wall; if so, what is the extent and operation of that communication?

A. At the furnace I could see no communication between them at all; I could not see any communication under the boilers; I was told of it; I did not see any.

Q. Did you understand that that communication was anything more than merely accidental—so small that it did not effect the operation of the furnace?

A. I could not say it was accidental, but I understand it was small.

Q. How large?

A. They did not state how large, but a very small space.

Q. Have you any reason to suppose that that communica-
367 tion was of sufficient size as at all to effect the action of this furnace; if so, on what do you base your opinion?

A. As to what was the extent of it; it did not occur to me as being of sufficient size to affect the action.

Q. What do you mean by alternate feeding in the sense of a Thompson patent of a fire arch to which there is but one feed-hole, from which there is no connection with any other fire arch, and no means by which the gases coming from that furnace can mingle with the gases from the other furnace or fire arch until they pass up the chimney?

A. I cannot say that I am sufficiently skilled to answer or to form a scientific opinion about it.

Q. How can you alternately feed one hole, or how can you feed a hole without feeding alternately?

A. I cannot answer that.

Q. Now, what do you state to be the difference between the construction of the upper furnace at Sparrowbush, at the time you first saw it, and on the occasion on which you last saw it, except the addition of the partition wall?

A. I do not remember, but my impression is that the partition wall was there then.

Q. When you speak of wood lying there, how much wood?

A. I cannot say; I know there was a very small quantity around.

Q. There is a canal passes right by the upper furnace?

A. No; right alongside of the tan yard.

Q. Was not the coal you saw deposited at the side of the canal?

A. It was at the side of the canal in the tan yard.

Q. You say that they used some dry tan; how do you know that?

A. The first time I was there I saw some dry tan, and then, once in a while, saw some thrown in; that was in 1870; this time they used no dry tan, nor did I see dry tan anywhere around the furnace.

Q. In 1870, when you were there, was not the upper furnace a very old one and out of order?

A. It was old and it was out of order.

Q. Do you not know that all the alterations that were made at the Sparrowbush furnace were simply putting in a new top, stopping up the cracks, and fixing the foundations, &c.?

A. No, I cannot say that; I remember the first time I looked upon it, and the last time it looked pretty much the same; it is not in perfect condition now; the lower one was perfect.

Q. What do you say was the alteration of the brick part or bridge wall?

A. That is all I recollect; I think also that the first bridge wall came up somewhere about seven or eight inches from the crown of the arch in 1870, when I was there; that is my impression.

Q. Now are you at all certain that there was not this second bridge wall in 1870?

A. To the best of my recollection it was not there, though I am not positive.

Q. All you know as to whether it was there in 1870 is what you derive from the recollection of your looking in it?

A. Yes, looking in, and I could see nothing interfering; I do not know that I could see very far.

Q. When you speak about a bridge wall in front of the upper furnace, is it at all anything more than the rear wall of the fire arch?

A. It is the rear wall of the fire arch carried up about 15 inches.

Q. Now, then, is not the length of the flue, from the fire arch into the broader space under the boiler, nothing but simply the thickness of the wall?

A. Yes.

Q. What is the distance in feet from this flue last referred to to the second bridge wall?

A. I should judge it would be from six to eight feet; I could not say exactly.

Q. About what is the distance from the second bridge wall you refer to to the rear end of the boiler?

A. About the same distance.

Q. Is it your opinion that wet tan, such as that burned at upper Sparrowbush, will fall through its grates?

A. The most I can say is that I think it might fall through some, as it is ground fine; I did not see any fall through except burning tan.

A. About what is the distance from the bottom of the grates to the bottom of the ash pits in that upper furnace?

A. I should say twenty inches to two feet; I did not measure it.

Q. You spoke of having closed the ash-pit doors from five minutes before 5 until eighteen minutes past 5; now what was the effect, during that time, on the fire in the furnace?

A. The most I can say is that the fire seemed to be steady—about the same—but I did not look in to see how the fire was.

Q. If I understand you, at the time you shut off the ash-pit doors the greater portion of, or all, the air would pass from the ash pit into the furnace?

A. Well, all I can say is, I did not know of any other space around where air could pass in, and the doors were closed.

Q. Now, do you not know that the coal is regularly landed on the side of the canal, at the point where you saw it, and that it is sold from that point and carried into the country?

A. No, I do not know it.

Q. Is there not a town there with a population of from 500 to 800 people?

A. There may be 300 or 400 people.

Q. Is there not a little town about a half a mile above that?

A. Yes, a few houses on the way. There is a hotel there.

Q. Now, in view of that state of facts, do you intend to
368 have the inference drawn from your statement that, because coal was landed there as you saw it, it was burned in these tanneries?

A. Well, I can only state from what was told me. As to my own observation, I do not mean to say what was done with it at all.

Q. Are you not aware that there are coal stoves in the houses of the proprietors of the tannery, and also in the houses of the employees of the tannery?

A. I could not say as to the employees. There are stoves in the tanneries. The proprietors of the tanneries have two coal stoves in their store. I was not in the houses of the proprietors.

Q. Are there not some rooms in the buildings at the upper tannery into which the heat of the furnace is not carried?

A. Well, I do not know of any. I did not go into all parts of it.

Q. Were you surprised when you banked up the ash pits with wet tan that the temporary effect of the steam from the same passing up through the furnace should be to lightly change the quantity of steam pressure in the boiler?

A. I had an impression it might change it more than I saw it did.

Q. Do you know how far apart the fire bricks are in the bottom of the fire chambers in those various Thompson furnaces that you visited?

A. I could not state that from recollection. I have a minute of this on my book, and I am sorry I did not bring it here.

Q. When you banked up the ash pit within one and a half or two inches of the top, did not that substantially close the open space into the ash pit?

A. No, it did not; it partially closed it.

Q. About how long did you operate the furnace in that way as banked?

A. Well, about half an hour.

Re-direct:

Q. In speaking of alternate feeding at the upper furnace, describe what you refer to.

A. By feeding first one oven and then waiting a little, a few minutes.

Q. How long?

A. I did not note it down; five or eight minutes; it might be until the oven was going, and then feeding the other.

Testimony of John W. Brackney.

JOHN W. BRACKNEY recalled by counsel for complainants.

Q. Have you seen the furnaces at the tanneries of Swazey, Cooper & Co., at Sparrowbush, of Stevens at Great Bend, and of Mr. Decker of Wellsburgh, and if so, when?

A. I have seen them. I saw the Decker furnace at Wellsburgh in September; Stevens' at Great Bend, about the middle of August, 1874; Swazey, Cooper & Co.'s on the 12th or 13th of November, and since, on the 25th of November.

Q. Do you know whether there were any ash-pit fires in either of those furnaces, and if so, in which of them?

A. There were ash-pit fires in all of them.

Q. How is that fire produced?

A. By charred tan falling through the grates.

Q. Have you visited tanneries in the tanning regions of this state and of Pennsylvania during the past year or so, and if so, about how many?

(Objected to as irrelevant and immaterial. Question allowed and exception taken by defendants.)

A. I have visited a good many tanneries; the exact number I do not know. I have a memorandum here of a good part of them—some 70 or 71.

Q. What portion of those tanneries are in this state?

A. Seven-eighths of them are in this state.

Q. What kind of fuel were they using in those tanneries?

A. Wet spent tan.

Q. Did you examine the furnaces they were burning wet spent tan in?

A. Yes.

Q. State whether or not you found any furnaces in any of those tanneries of the form and construction like those at Sparrowbush, Stevens' at Great Bend, and Decker's at Wellsburgh?

(Objected to as immaterial. Question withdrawn.)

Q. Among the places that you visited did you visit the Wells & Stratton tannery, at Addison?

A. I did.

Q. State whether there were any ash-pit fires in those furnaces.

A. There seemed to be about the same as in the others.

Q. Now state whether you found in any of the other furnaces you so visited such a form of furnace as either of those at Sparrowbush, Great Bend, Wellsburgh, or Addison, which you have mentioned?

(Objected to by counsel for defendants, first, as irrelevant and immaterial; second, because it calls for an opinion as to the structure of the furnaces, or of the application of the patent to them, and this witness is not shown to be competent to give an opinion.)

Cross-examination:

Q. Have you at any time, and if so when and where, studied any branch of science or of mechanical arts?

A. I never have.

Q. Have you ever studied law, or any branch of law?

A. I have not.

Q. Have you ever studied any branch of knowledge with reference to being a scientific expert? If so, where?

A. I have not.

Q. Have you ever been examined as a scientific expert, and if so, when and where and in what cases?

A. I have never been so examined anywhere.

Q. Do you claim to be competent to construe or interpret or apply patents, and if so, on what do you base your claim to such competency?

A. I do not pretend to do that. I have studied no science.

369 Re-direct examination resumed:

(The referee passes on the question by allowing it. Defendants' counsel takes an exception.)

A. These are the only ones that I saw on my visit in the tanneries. I saw no other in the tanneries I visited constructed in the same manner.

Q. Describe the kind you did see in those tanneries.

(Same objection as to last question, objected to, and same ruling. Exception by defendants' counsel.)

A. Most of the others were constructed in the form and style of that built at Brackneyville, Susquehanna county, Pa.

Q. You mean the furnace which you have described, and which you put up at Brackneyville for burning wet tan?

A. Yes; the same thing.

Q. About how many of them were constructed in that manner?

A. Probably over fifty; I think about fifty.

Q. Did you see the old furnaces at Laporte and Thorndale before they were torn down?

A. I did.

Q. Were those fifty constructed like them?

(Objected to by defendants' counsel because the witness is not an expert, nor competent to express an opinion. Question allowed. Exception taken by defendants' counsel.)

A. The same thing.

Q. How were the others constructed of those seventy?

A. Some of them were burning tan under the boiler in cone grates and oval grates; the only ones I came across were cone grates. Sparrowbush, Stevens, Addison, and Wellsburgh—these are the only three kinds I saw.

Q. In those cone or oval grates under the boiler did they use any dry fuel with the wet tan?

A. They did; coal or wood.

Q. Did they use any tanning material?

A. Yes; some used rosin.

Q. What kind of tanneries did you visit—sole leather or upper leather tanneries?

A. Mostly sole leather.

Q. Did you visit all the tanneries in the district you went to that you could find where they were burning wet tan?

A. I think I did.

Q. Name some of the principal counties you visited.

A. I was in Chenango, Broome, Cattaraugus, Steuben, Saratoga, part of Fulton, Erie, Chemung, Oswego, Cayuga—I do not recollect them all.

Q. And in Pennsylvania where did you go; do you recollect the counties.

A. Susquehanna, Wyoming, and Wayne; that is all that I recollect.

Q. Did you visit Bush & Howard's and Rumsey's tanneries, at Buffalo?

A. I did.

Q. What kind of furnaces did they have in them?

(Objected to, that the witness is incompetent to express an opinion on that question; question allowed; exception taken by defendants' counsel.)

A. Bush & Howard, at Buffalo, had one Thompson furnace—one with cone grates under the boilers.

(Counsel for defendants moves to strike out that part of the answer in which the witness says it is a Thompson furnace, on the ground that it is an opinion that the witness is not competent to express. Motion denied by the master, and exception taken by defendants' counsel.)

Q. Now as to Rumsey's?

A. Rumsey had one set of Thompson ovens—furnaces with three ovens in the arch, and another one with one; they had also one small one under one end of the boiler burning wet tan on grates.

Q. Were those tanneries of Bush & Howard's and Rumsey's large ones?

A. Yes, very large tanneries.

Cross-examination resumed:

Q. You speak of their burning coal or wood in some of those tanneries; which ones do you refer to?

A. At Rumsey's on cone grates they burn coal, and at Bush & Howard's on cone grates under the boiler they burn coal and tan; at Sieger & Co.'s, of Buffalo, they burn coal with tan on cone grates under the boiler. I found no other grates in which they burned coal or wood. There were two or three at Buffalo, and I think another at Post.

Q. State the time, giving the month and day, when you visited each of those furnaces at which either wood or coal was so burned, and state how long you remained at each, and who was present with you.

A. I could tell the time if I had my memorandum book. [Memorandum book produced, and witness refers to it.] I visited Bush and Howard, at Buffalo, on the 30th of April, 1874. I was at Buffalo four days in April and May.

Q. How long were you in the works?

A. I was there every day; I think I was there every day while I was in town.

Q. How long did you stay at any one of them?

A. From one to two hours.

Q. Who was present?

A. At Bush & Howard's the foreman went with me to the engines.

Q. How as to the others?

A. I see 3d May I was at Sieger & Gessler's.

Q. I am speaking now of those where you say you saw wood or coal burned.

A. Levi Barrett's, Olean, Cattaraugus county, is another cone-grate furnace. I was there on the 27th April, 1874.

Q. How long were you there?

A. About an hour with the foreman and the two partners.

Q. You say that you saw coal or wood burned there?

A. Yes; Mr. Barrett was with me, and told me all about it; I would not be sure that I saw wood put in. I was at Wheeler & Wright's, Portville, on the 28th April, 1874.

Q. How long were you there?

A. I was there an hour.

370 Q. Can you state any other place at which you saw either wood or coal burned in a furnace; if so, state the date you were there, and where the furnace is?

A. Hill's, Wellsville, 27th April, 1874; I was there a couple of hours; I did not see either coal or wood burned; William McVey's, Steuben co.; I saw wood in his furnace with tan; saw him use it.

Q. Is that one of the furnaces which you have referred to as a cone furnace, or furnace under the boiler?

A. A furnace directly under the boiler—fire grates under the boiler.

Q. What time of the day or morning were you there?

A. At McVey's?

Q. Yes.

A. April 22d, 1874; I was there after 12 o'clock; I was there a couple of hours.

Q. Did you ever see the Woodstock furnace?

A. I have never seen it.

Q. What is your relation to this case in respect to being employed in it, and on what terms and conditions are you employed in it?

A. I am employed by Mr. Black; I have no interest in it myself.

Q. At what rate are you paid, and how much have you been paid?

(Objected to. Objection sustained and exception taken.)

Q. How long have you been employed in this case?

A. I have done some business in it—I think 1869 was the first.

Q. Employed in it ever since?

A. More or less.

Q. What is your business, and where do you reside?

A. I reside now in New Jersey; I have no business except this, acting under Mr. Black's directions.

Q. Is your payment conditional on the result of this litigation?

A. Not at all.

Q. What are you employed to do?

A. I do not know; I do whatever I am told; when he asks me to travel and do anything about it I go.

Q. How long has it been since you have had no other business except to act as agent in this case?

(Objected to.)

A. I have not been in any regular business since 1868.

Q. Are you paid a regular compensation by the month or year, or how?

A. I do not know; I put in charges as I do the work.

Q. No fixed compensation; are you paid according to the manner of how you do it?

A. Mr. Black employed me, and I expect he will pay me.

Q. You carried on a tannery at Brackneyville, Pa.?

A. Yes.

Q. How extensive a tannery was it?

A. It had a capacity of 25,000 hides a year; I do not think it ran up to that.

Q. During what time did that tannery go on?

A. I built in 1850 and ran it to 1868.

Q. Do you know how extensive are the tanneries of Harrington & Co. and of Tremaine & Co.?

A. Tremaine's tannery is a moderate-sized one, with probably a capacity of 10,000 hides a year; the other one I do not know.

Q. Do you know anything of Babcock, Gibbs & Co.'s tannery at New Berlin, N. Y.?

A. I do not know about it.

Q. Your attention is called to the list of tanneries and prices paid under the Thompson patent for its use as contained on page 250 of complainant's exhibit, and you are asked what you know of the tanneries mentioned in that list—what you know about the size of those tanneries?

A. Some of them are large, but I do not know the capacity of the whole of them. J. D. Hamilton's is a large tannery, with a capacity of 20,000 or 25,000 hides; J. Hand's and J. Kesled's, 20,000; Frazer & Hagan's, 10,000; Lewis Rider's, Florence, N. Y., about 10,000 hides; Pigot's, at Elmira, 10,000 hides; Bidwell's, at Brashear, about 10,000.

Q. What did you pay for the license you took in the Brackney furnace?

A. Well, my recollection is $100 or $150.

Q. That was for its use during the patent?

A. Yes, sir.

Q. When did you take it?

A. 1856–7; I do not recollect which.

Q. Do you know those other gentlemen mentioned in the list having licenses?

A. I do not know anything of it.

Q. Do you know of anybody else at or near that time paying a license for a Thompson furnace?

A. I do not.

Q. So long as you carried on the work at Brackneyville did you avail yourself of the license?

A. I used the license.

Q. Did you apply for the license or were you requested to take it?

A. I made application of Mr. Thompson.

Q. Did you act for Mr. Thompson somewhat along about that time?

A. Not at all.

Q. Do you know at what rate anybody else has ever paid for those licenses prior to the commencement of this suit except yourself?

A. No; I do not know of my own knowledge what was paid.

Re-direct:

Q. Have you known of any one taking a license for those furnaces since this suit was decided?

(Defendant's counsel objects to any proof of the rate charged since the commencement of the litigation, and particularly objects to any proofs relating to such charges since the termination of the infringement as being immaterial and irrelevant. Objection overruled, and exception taken by defendant's counsel.)

A. I have.

Q. Do you know Truman Brothers, of Oswego?

A. Yes; they are tanners; their tannery is situated near Oswego; its capacity is 20,000 hides, I should think.

Q. Do you know of a license taken for that tannery since this suit was decided?

371 (Objected to for the reasons last mentioned, and because, if the license is in writing, it must be produced.)

Re-cross examined:

Q. Was there not a written license?

A. I do not know.

Q. How did you derive your information on the subject?

A. By negotiating myself with Mr. Truman for this license.

Q. You derived it from him?

A. Yes, making an agreement with him for the license.

Q. Was not that reduced to writing?

A. Not with me.

Q. Did you not know it was afterward?

A. I understood it was.

(Counsel for defendant renews his objection. Counsel for complainant agrees to produce a press copy of the license.)

Re-direct:

Q. Just state what license fee you agreed on?

(Objected to by defendants' counsel. Objection overruled.)

A. $1,500.

Q. What is the business of Truman Brothers?

A. Tanners, bankers, and lumbermen, near Oswego, and they have tanned from 15,000 to 20,000 hides a year.

Re-cross examined:

Q. What was the date of negotiating that contract?
A. I think it was in March or April of this year—1874.
Q. Did you understand that it was for the residue of the patent?
A. It was during the patent of Thompson.
Q. Did you understand it was to cover any claim for past damages?
A. To cover past damages and future use.

Professor THURSTON recalled:

Q. You stated, on cross-examination, that the temperature of a Thompson furnace was approximately that due the theoretical action of the fuel and a restrictive air supply. If you have proof of this state it, and also state why you declined on cross-examination to swear that the temperature of the furnace was above 2,000° Fahrenheit.

(Defendant's counsel objects to each branch of the question separately; first, as immaterial; second, as an opportunity attempted to be secured by the plaintiffs to have the witness to state anything he chooses to state on the subject of this litigation, which is unjust to this defense and contrary to the rule of examination. Question allowed. Defendants' counsel excepts to each branch of the question separately.)

A. In determining the air supply in a Thompson furnace I have first determined the theoretical temperature of furnace; next, the temperature of the furnace as deduced from the temperature of escaping gases. The difference of temperature is due to the dilution of heat and reduction of temperature by the entrance of a surplus of air over that required theoretically. Taking Box's estimate of the value of fuel—6,480 thermal units per pound of dry wood—and taking Box's estimate of the loss by radiation and as escaping through the top of the furnace, thus drying the fuel to the extent of 3 per cent., I find the theoretical temperature due to the fuel entering the furnace with the composition of 55 per cent. water and 45 per cent. dry wood to be 2,320°, which is reduced by the loss just referred to to 2,260°; but with such composition of fuel the temperature of furnace deduced from the temperature of escaping gases determined by experiment becomes 2,118°. This difference of 142° allows 40.75 units per pound of furnace gas over 150.8 units per pound of wet tan, or, again, 335.1 units per pound of wood in the wet tan. This amount of heat would rise .69 pounds of air from the mean temperature of external atmosphere to the temperature of furnace gas, as shown by experiment; but six pounds of air are theoretically required per pound of wood. Hence the products of combustion are diluted with 12 per cent. of unconsumed air. It therefore follows that the temperature of the Thompson furnace was that due the

theoretical action of the fuel with the restricted air supply, the dilution being in this case less than one-fourth that given by Rankine as the least obtainable that ordinary practice ever calls for. I declined on cross-examination to swear that the temperature was above 2,000 degrees Fah., partly because I had not then made those calculations with such accuracy as to permit me to make the statement as positively as I am willing to make it now, and partly from the fact—which had already, I think, been stated—that although this was to my mind conclusive proof, I had not been able to check it by direct experiment on the temperature of the furnace.

Q. Is it possible that the mean temperature of the furnace can be higher than that due the composition of wood fuel, as you have reckoned, and if so, how is that to be explained?

A. The mean temperature of furnace may be higher than that due the theoretical calorific power of the fuel as it has here been estimated. It is explained by the fact that those estimates all assume that the moisture driven off from the fuel passes up the chimney at the full mean temperature so determined. The real fact is that upon the entrance of a fresh charge of wet fuel a portion of moisture is expelled rapidly and passes off at a temperature very much lower than the mean temperature, and comparatively little passes off at the maximum temperature. The whole mass of moisture is not, therefore, in my opinion, necessarily raised to the full mean
372 temperature given by those estimates, consequently the mean temperature of furnace may be higher than is estimated; in the interval between the drying of one charge and the introduction of the next the dry fuel develops a temperature which is that due to dry wood; these considerations have not entered into my statement, because I know of no means of determining how far they may affect those estimates.

Q. Are you able to show that the temperature of furnace at Weed's, in your experiments, was higher than the defendant assumes the temperature to have been in it before Prof. Chandler visited it, as stated in his testimony? If so, state.

A. The determination of the temperature of furnace from the experimental determination of temperature of escaping gases I consider to be conclusive proof that the temperature at the time of Prof. Chandler's visit was lower than at the time of my experiments. It is also proven, as appears to me conclusively, by the fact that to obtain the efficiency of furnace that I obtained at my experiments, with the same temperature of chimney and gases, it would be necessary to supply the furnace with fuel almost dry.

Q. Can the results you have given, bearing upon the relative temperature of furnace, be proven correct by any independent method of proof? If so, state what it is.

A. It can be proven by an entirely independent method of proof. The efficiency of the heating apparatus is marked by a ratio of the difference between the temperature of furnace and chimney to the difference between the temperature of furnace and external air

taking the temperature as I have estimated them in my latest calculation, I find for a Thompson furnace an efficiency due to those temperatures of $\frac{2.118 - 544}{2.118 - 74} = 0.77$, and for the Crockett furnace I obtain $\frac{919 - 452\frac{3}{4}}{919 - 86.5} = 0.56$, but the efficiency of fuel, as it is recorded in my estimate of results, excludes the heat lost as latent; hence the efficiency of fuel in a Thompson becomes $0.77(1 - 0.182) = 0.63$, and for a Crockett furnace I get $0.56(1 - 0.182) = 0.46$. By Crockett furnace I mean that at Sparrowbush.

But the actual efficiency, as shown by experiments, if referred to units, in the calorific fuel of 6.480 thermal units, is 0.63 and 0.47 for a Thompson and a Crockett respectively; hence the difference in efficiency of those two furnaces is attributable to this difference of temperature, being that precisely due to such difference of temperature, and the fact is the proof that those temperatures are correctly estimated.

Q. Do you regard the furnaces at Laporte and Thorndale as you saw them, as you have stated, within either of the clauses of Thompson's patent, and if so, which?

(Counsel for defendants objects to the question because the witness declined to answer a question as to the construction of those patents, or whether a given structure was within the patent, for the reason that he had not considered it, and he should not be allowed at this stage to enter on that subject; counsel also objects that these furnaces now in use are not the same in structure as those used at the time to which this accounting refers, and that there has been no proceeding or determination in court to show that the present furnaces in anywise infringe the patent or are claimed to have been infringed by the defendant; and counsel claims that this accounting cannot be brought down to a later period than July 23d, 1873, the period to which the master brought the last accounting, and that the furnaces now in use and in use since that date are different furnaces from the prior ones and have not been decided to infringe, and the complainants have not taken any proceedings to show that they are infringements. Objection overruled and exception taken.)

A. They infringe the claim of the reissued patent March 31st, 1857.

Cross-examined:

Q. Could you not, by your process and the use of your elements in regard to theoretical heat and actual heat, generally referred to in your examination, determine about how hot the water in a boiler is when the fire had been going a time, or had been sufficient to raise it to the boiling point?

A. I do not now see how I could, although I think that the elements are sufficient to solve such a problem.

Q. The elements, at all events, are sufficient in your estimation to show how much is the heat of a furnace, even if not sufficient to show how much is the heat of the boiler, are they not?

A. They are only sufficient to determine the mean temperature of such a lengthy trial, but I cannot from them determine the temperature of furnace after starting the fires, and before those fires have got well under way.

Q. Do you mean that they are sufficient to determine the mean temperature of furnace without being sufficient to determine its mean temperature at any particular time?

A. That is what I mean.

Q. Then your theoretical process is one under which you can determine the average result of thirteen hours and over of heating a furnace without being able to tell at any time how hot the furnace was?

A. Precisely that.

Q. Then I take it that it is indefinite what the actual heat
373 was at any particular time?

A. So far as those estimates are concerned, yes.

Q. Now, sir, if you had exposed in that furnace to its heat once in an hour a metal which would melt at much less than 200° of heat, and could not melt it in the furnace, would that shake your views about its theoretical heat or actual heat?

A. I should consider it evidence that the actual heat was below the melting point of that metal.

Q. Now, supposing you had hung in what, according to your theory, was the hottest place in that furnace, a sheet of foil, or of a very thin substance of metal which would melt at 1,700° or under, and the metal had remained at that point during the whole period of your test unmelted, have you such an abiding faith in your theory as to theoretical heat as to think that the average heat of that furnace was 2,000°, despite that unmelted metal?

A. Certainly not.

Q. Might not a tin foil or sheet of some such kind of metal be hung or exposed in that furnace, and if not, why not?

A. I should suppose that there might.

Q. Then, as a scientific man, shall I understand that you ask us to accept, as conclusive, your theoretical test in presence of the admitted fact that a practical test might have been applied which is of a higher order of proof than your theories?

(Objected to by complainants' counsel as an assumption not warranted by anything which has appeared in evidence.)

A. I have already stated that the temperature of furnace, as I have given it here, is, in my opinion, not a theoretical temperature in the sense in which I understand the question, but is a temperature proven to have actually existed as an average at the time of my experiments, and is one which is sufficiently well established, as I have shown, to justify my placing it in evidence without other method of proof.

Q. Now, sir, do you claim to know or to have any reliable scientific or actual information which enables you to state what the temperature of furnace was at any particular hour or minute of your testing it, and if you do, state the hour and the minute to which you refer, and if you do not, tell us what you mean by an average heat when you do not know the heat at any particular time?

A. I have no means of determining the temperature of furnace at any specified hour or minute; the temperature which it is essential to know, so far as my results go, is the average temperature for the period during which my experiments were in progress; I know of no way of explaining my use of the term "average," or my method of deduction, more precisely than in the words which I have already given.

Q. Did you not, with a view to test the actual heat of the gases in the stack or flue leading into the stack, put in a lump of cold iron and then proceed to estimate the temperature from the amount of heat you found in the iron?

A. I did.

Q. Why could you not have pursued the same process with the furnace itself?

A. I could have done so possibly, but it was my opinion at the time that I should have melted down my mass of iron in the furnace, and by interfering with the covering of the feed holes, or, by opening of the furnace in handling this iron, interfered slightly with the working of the furnace, and should have obtained no satisfactory result.

Q. At what degree does cast iron melt?

A. About 2,750°.

Q. Could you not determine the degree of heat in a furnace from the rapidity with which it raised the cast iron to a white heat?

A. I do not think that I could have done so.

Q. Does not your experiment—taking the heat of the fuel by the use of iron—have reference to the length of time it took to heat the iron?

A. None at all.

Q. Is it the result of your theoretical estimates that the heat of that furnace was as much as, or exceeded, 2,700°?

A. It is not.

Q. Do you reconcile your confidence in your theory which gives a heat so much less than the melting point of cast iron with your fear that cast iron would be melted?

A. I derive my opinion that cast iron would have melted if I put it in there from an observation of the furnace through the feed holes, and I am not, even now, at all confident that it would not have been the fact, since it is my opinion that there are times when the fuel within the furnace has become so nearly dry in the intervals between successive charges that the temperature may approximate very closely to that of dry fuel and a restricted air supply; there is no difficulty in reconciling this fact with the existence of the mean temperature

which I have shown to be approximately 2,100°, and possibly higher, as determined by what the question assumes as mere theory, but which I consider absolutely proven, since the estimate of mean temperature has no reference to actual temperature at any specific time or to either maximum or minimum temperature in the furnace.

Q. How often was this furnace fed?

A. I did not know the times.

Q. State as near as you can.

A. It would be mere guess.

Q. Make the guess.

A. I prefer not to make a hypothesis, as I paid no attention at all to this matter.

Q. Have you or not, as you understand your answers, already stated that the furnace was fed as often as once in 15 minutes or oftener?

374 A. I have not.

Q. Do you know that it was fed at all while you were there?

A. Yes, I saw it.

Q. How often?

A. Quite frequently, but I cannot say how often.

Q. State whether or not it was fed more or less than once in ten minutes, in your opinion.

A. I should think less frequently than that.

Q. As often as once in fifteen minutes?

A. I cannot say.

Q. Shall we correctly understand in assuming your testimony to mean that in your opinion, then, the heat of this furnace would rise and fall several hundred degrees in the intervals in the several times of feeding?

A. Not that it would do so, but such an occurrence is not improbable at times.

Q. What, in your opinion, would be the effect of limiting the air supply to this Sparrowbush furnace by partly closing the doors or otherwise limiting the access of air beneath it?

A. I should expect it to increase its efficiency.

Q. Have you read the testimony of Mr. Rea?

A. I have not.

Q. If, then, the air supply were increased, the furnace would tend to approach the efficiency of a Thompson furnace, would it not?

A. I should think it would tend to approach it.

Q. Well, supposing in the use of the Sparrowbush furnace they stopped part of the apertures allowing air, would that make an infringement of the Thompson furnace in your opinion?

A. In my opinion it would indirectly make the infringement more manifest.

Q. You still adhere to the opinion, then, that the Sparrowbush furnace is an infringement of the Thompson furnace, do you?

A. As I saw it, certainly.

Q. Now, what proportion of opened door that lets air under the ash pit would you have to stop up to make it the most complete infringement of a Thompson furnace you could make out?

A. I do not know.

Q. Shall I correctly understand you to assume that just in proportion as you should bank up the open space that led under the ash pit, you would make this Sparrowbush furnace on your theory a more actual infringement of the Thompson furnace?

A. No, sir.

Q. What proportion of wall under the ash pits would you need to bank up to make it a most complete infringement, according to your theory?

A. Such a proportion as should insure the most efficient ash-pit fire, at the same time allowing a most effective supply of air.

Q. Now, then, supposing that instead of stopping off the air supply in part, by closing up the doors you should stop off the air until, by putting in a quantity of sand on the bottom of the ash pit, it stopped, and the whole came down to the minimum point you refer to, and put out all the fire in the ash pit, what, in your opinion, would be the effect on the Sparrowbush furnace?

A. That the fire would go out.

Q. What, in your opinion, would be the effect if you should bank up that ash pit with wet tan so as to considerably decrease the amount of air going into it; what, in your opinion, would be the effect?

A. The same as other methods of choking draft.

Q. If this Sparrowbush furnace, then, was used in such form as to admit a less amount of air into the ash pit than in your experiments, you would have expected a greater briskness of fire and more efficiency as exhibited in the water evaporated, would you not?

A. I should.

Q. What part of the Thompson furnace would be infringed when you shut the door of the ash pit one-half or two-thirds together, when the furnace was in action, which would not have been infringed if you had left it stand open so as to admit a larger amount of air?

A. No new claim would be infringed.

Q. If no now claim, what old claim?

A. A claim which covers a fire above and below the grates.

Q. The question put to you assumes the ash-pit fires to be the same in both cases, or, in other words, none in either case. Please answer the question in reference to that assumption.

A. On such an assumption the claim to which I have just referred would not be infringed.

Q. What claim would be?

A. The claim of the reissued patent, March 31st, 1857.

Q. What part of it would be infringed?

A. The first claim.

Re-direct:

Q. What assumption do you refer to in reply to the cross inter-

rogatory given above; state if such an assumption is at all probable?

A. I refer to the assumption of the counsel for the defendant that there is no fire in the ash pit in the case which he supposes; in my opinion the effect would actually be that the restriction of the draft in the Sparrowbush furnace would increase the amount of ash-pit fire, other things being equal; and this also increases the efficiency of the furnace, rendering the infringement, now evident, still more marked.

Q. In ordinary practice, what would cause the heat of a furnace such as Weed's to vary?

A. The alternation of temperature would be due to feeding wet fuel into the furnace, its drying and subsequent combustion of combustible dry fuel.

Re-cross:

375 Q. Had not the furnaces you refer to to-day as having seen at Laporte and Thorndale only single feed holes to each fire arch?

A. They had but one.

Q. And was there not a wall running along under the boilers to the stack, or nearly so, from each oven, so that there was no connection of the gases from one furnace to the other until you got back to the chimney?

A. That was the construction as it appeared to me; there was no fire in the ash pit.

Re-direct:

Q. State how those Laporte and Thorndale furnaces could be fed alternately?

(Objected to as a mere theoretical question; the question should be limited to the inquiry—how they were fed. Question allowed; defendant excepts.)

A. There are doors on the side of each oven, through which alternate feeding could be quite conveniently performed.

Evidence of William H. Plumb.

WILLIAM H. PLUMB, called and sworn as a witness on the part of complainants, deposes and says:

I have been examined before in this case.

Question. Mr. Webster stated in his testimony on this accounting that the furnace you built at his tannery at Edgeworth did not burn the wet tan successfully. State how successfully it did do it when you were there.

A. I have already given, in my former evidence, the amount of evaporation with a given amount of fuel; a short time after this furnace in question was built I went there to show the engineer how to operate it; I saw from my own observation that he had so much

work to perform that he could not attend to the working of the furnace sufficiently; the furnace was built on low, marshy ground, and at high water the ash-pit chambers, where the carbonaceous fire is maintained, were submerged, consequently the furnace could not be worked to the advantage that its proportions and conditions demanded for the amount of duty to be performed.

Q. Did you, when at Saxonville using that furnace, make experiments in burning wet peat with the doors of the ovens and ash pits entirely closed; if so, for what length of time and with what results, and how wet was the fuel used?

(Objected to as irrelevant and immaterial. Overruled and exception taken.)

A. I did for several days and nights in succession, with peat containing at different times from 50 per cent. to over 70 per cent. of water, and without the help of any other fuel; the combustion with closed ash-pits doors was somewhat inferior to the combustion as followed by Thompson's instructions, but there was a high degree of efficiency in the evaporation of the water under the boiler under these circumstances.

Q. Have you seen the furnaces of James K. Mosser, at Hanover, Lehigh co., Penn., and if so, when did you see them last?

A. I have; I saw them the 8th day of January last.

Q. How many ovens are there attached to the boilers of those furnaces?

A. Two attached to three boilers in one nest, and in another place one of them connected with three boilers in one nest.

Q. In the case where there are two ovens attached to three boilers in one nest, how does the products of combustion reach the boilers from these two ovens?

A. From the one immediately in front of the boilers they pass directly through a contracted opening at the rear of the oven; from the adjacent oven they pass into a flue built at the rear, a contracted opening leading thereto, which flue runs in under the boilers at right angles, just behind the wall of the oven first spoken of.

Q. How does that flue attached to this adjacent oven differ, if at all, from the flue described by Thompson in his reissued patent of March 31st, 1857?

A. It is substantially the same thing.

Q. Do you find this adjacent oven you have referred to on the drawing now shown you, marked Defendants' Exhibit No. 1, July 1st, 1874?

A. I find simply the oven built directly in front of the boilers, but not the one adjacent.

Q. Do these furnaces, as you saw them in operation, infringe either of the claims of Thompson in his patents, the reissued patent of March 31st, 1857, and patent of Dec. 15th, 1857?

A. They do in every point excepting the maintenance of a carbonaceous fire in the ash pit.

Q. Have you visited either of the tanneries of Joseph B. Hoyt & Co., in Maryland and Pennsylvania, and if so, which?

A. I visited three of their tanneries in the fall of 1873; one called the Will's Creek, Cumberland, Maryland; one at Everett and one at Ray's Hill, Bedford co., Pennsylvania.

Q. Did you find furnaces at those tanneries in which they were burning wet tan; if so, state how they were constructed?

A. The furnace in operation at Ray's Hill was built in front of the boilers and had four feed holes at the top; at right angles to this furnace was built a new furnace, which had not yet been used, of about the same dimensions and appointments as the other; the products of combustion would pass through under the boilers; a contracted flue dropped about 18 inches from the top of the arch; we have, in the construction of this furnace, every provision made by Thompson in building his furnaces, excepting the fire in the ash pit; at Ray's Hill we have one boiler placed at the end of an oven, which oven has but three feed holes; a central pier is built up from the back end of the oven, apparently for the purpose of sup-
376 porting the boiler; the flues are dropped about two feet below the top of the arch, and are contracted still more by angular shaped dams at the back of the oven; at the Everett tannery they were constructing a new furnace, evidently like those in the preceding description; it was about half finished.

Q. Were those furnaces in operation when you were there burning wet tan?

A. One of the furnaces at Ray's Hill and one at Will's Creek was in operation.

Q. How wet was the tan used in them?

A. It was the same as where wet tan is generally burned; it does not vary much.

Q. (By the master.) What do you mean by that; as it comes from the leaches?

A. In the neighborhood of 60 per cent. water, as it is burned as it comes from the leaches.

Q. How is it fed into the furnace—by what process?

A. The engineer would commence at one end of the furnace and feed through one of the top feed holes sufficient spent tan to make a cone reaching to the top of the arch—clear up to the top, and then would go to the next, and so on to the end of the furnace.

Q. What provision was made in these furnaces for draft, if any?

A. The spaces between the grate bars were about a quarter of an inch; it varys a little trifle, sometimes a little less or a little more; that is not an absolute measurement; they had ash pits to the middle doors that fed a supply of air to the fuel.

Q. What was the appearance of these ash pits when the furnaces were in operation?

A. There was no fire in them.

Q. In looking into these ash pits could you see any fire in the upper chambers?

A. I did, and the cones were, of course, under various stages of combustion, according to the length of time the fire had been fed in; that is, those that were first fed were soonest under way.

Q. What was the effect, Mr. Plumb, upon the draft of these furnaces of feeding them with this wet tan from the top, and permitting these cones of tan to rest, as you have described, on the grate bars; was it or was it not to give it a limited supply of air?

A. Feeding in that manner would exclude the air practically, and it would only be when the cones had burnt down to a certain extent that the air could be permitted to enter; that would be at a time when the air would not be most needed.

Q. Then, according to the ordinary practice in furnaces, when the air (the atmospheric air) was most needed to keep up the combustion, if at all, a limited supply of air could get to the upper chambers; is that so?

A. Yes, sir.

Q. How does the combustion in these furnaces compare with the combustion in a Thompson furnace, built in accordance with his claims, for burning wet fuel?

A. So far as I have experimented I have already determined the superiority of the Thompson furnace, and I know from practical observation that there is a much higher degree of heat in the Thompson furnace than can be obtained from any other form, or any departure from his particular form of building that I have ever seen.

Q. Do you consider these furnaces that you saw at Hoyt's tanneries as infringing either of the claims of Thompson's said patents; if so, which?

A. Your question is this: you want to know which claim?

Q. Yes.

A. All the claims, excepting the hot fire in the ash pit.

Q. Where did you make an actual experiment of the evaporative power of a furnace built after the fashion of Hoyt's?

A. At Laporte, Sullivan co., at the tannery of Thorne, McFarlane & Co.

Q. State the results of your experiments?

A. On the 12th day of October, 1872, I tested the economical working of the furnace at Laporte from 8 o'clock and 25 minutes in the morning until 3 o'clock and 8 minutes in the afternoon, such furnace doing its usual work; that during said time said furnace evaporated 15,718 75-100 pounds of water, consuming 14,519 pounds of wet tan, containing 62 per cent. of water; a cord of this tan-bark weighs 4,252 pounds, making 3 4-10 cords of tan-bark.

Q. Have you examined the furnace of Kiersted, at Mongaup Valley, when Professor Thurston was present?

A. I did.

Q. Do you consider that furnace, as constructed with one feed hole, an infringement of Thompson's?

A. I do.

Cross-examination of Mr. PLUMB:

Q. Have you made such experiments in burning wet tan and other fuels that you can state the comparative efficiency of a cord of wet tan compared to an equal quantity of wood or coal, as used in ordinary practice; if so, state?

A. In our practice in the East, where we use wood partly hard, partly soft, we found two cords of hard dry wood doing the work of a ton of coal, and found that comparing the evaporative value of coal with that of wet tan-bark used in the Thompson furnaces, that a cord of that bark will perform the same amount of evaporation as a half ton of coal, making it equivalent to wood; I state this as the result of my experiments and practical observation.

Q. Have you changed your views in regard to the construction of this patent or in regard to the economy of its use since you were previously examined in this case?

A. I have not.

Q. Then you stand by and reaffirm all you have previously said?

A. Yes, sir.

Q. And if any part of it contradicts what you have said,
377 what are we to believe?

(Objected to as incompetent and improper.)

A. I do not admit that a contradiction exists in my statements.

Q. Have you read the testimony of Professor Thurston on this accounting?

A. I have not entirely.

Q. Have you read those expressions in which he speaks of the relative economy and efficiency of wet and dry fuel?

A. But partially; I have glanced over his statements.

Q. Do you agree with him as to the superiority of dry fuel to wet fuel, or as to the economy of it?

A. I do practically agree with him.

Q. In your opinion, which will, in a Thompson furnace, develop the most heat, a ton of dry tan or that ton of dry tan supplied with water until as wet as when taken ordinarily from the leach?

A. That depends on how it is consumed; I should say it would burn wet fuel better than dry.

Q. Which will develop the most heat?

A. I say that as the Thompson furnace is constructed, the wet tan would, in my knowledge, give the highest degree of heat; it would be more efficient with the wet fuel.

Q. Have you seen the Weed furnace?

A. I have.

Q. When did you see it last?

A. I think it was August last, 1874.

Q. Is it your opinion that a cord of tan taken wet from the leaches at the Weed furnace will develop more heat when burnt in that furnace than that same tan would if dried and burned in that furnace?

A. I do.

Q. Do you understand such to be the opinion of Professor Thurston?

A. I am not familiar enough with his exact language to know what his opinion is.

Q. Did you ever make any experiments with the furnace at Weed's?

A. Never.

Q. Is that a good specimen of the Thompson furnace?

A. It is.

Q. Is there any way in which you could improve it to make it a better furnace?

A. Not to my knowledge.

Q. If it should be proved by actual experiment in that furnace that a cord of dry tan would give more heat therein than would the same cord of tan when used as wet as tan taken from the leaches, would you still adhere in your opinion that wet tan would give more heat than dry tan in a Thompson furnace?

A. I certainly should not if it was proved.

Q. Do you know Professor Thurston?

A. I have met him but on that occasion.

Q. What is his reputation as a scientific man?

(Objected to; overruled; exception taken.)

A. I am not qualified to tell; he stands high as a man of scientific talent pertaining to practical engineering attainments.

Q. If presented as the result of his experiments at Weed's furnace that a cord of dry tan develops more heat in that furnace than the same cord of tan when wet as taken from the leaches, would you accept that as satisfactory evidence on the point?

(Objected to.)

A. Not necessarily.

Q. Why not?

A. Because there might be errors arising that I should want to take cognizance of myself.

Q. Then you have not such confidence in Professor Thurston's test of the furnace that you would be willing to adopt it without retesting it, have you?

A. I have full confidence in his ability, conscientiousness, and accuracy, but I always investigate a matter of this kind for myself; I have made that a rule in my life.

Q. When and where did you ever try the experiment whether a cord or any given amount of dry fuel burnt in a Thompson furnace would or would not produce more heat, or was or was not more economical than the burning of the same fuel after you had put water enough on it to make it as wet as tan taken from the leaches?

A. At Saxonville I burned what was considered dry wood, September 26th, 1865.

Q. State the amount of dry fuel, and what it was that you burned.

A. It was hard wood, containing a little over 20 per cent. of water.

Q. State the amount of wet fuel and what it was that you burned in the last-mentioned experiment—in the same experiment?

A. I did not have the same experiment.

Q. Did you ever, in the same furnace and at or near the same time, make a comparative experiment of the heat developed by wet fuel as compared with dry fuel in a Thompson furnace, and if so, when and where was that comparative experiment made?

A. I did, in the month of October of the same year; it was in the same furnace.

Q. Was the experiment made on one day?

A. No.

Q. How many days?

A. It ran through several weeks.

Q. What was the kind of dry fuel you burned during that experiment, and how much did you burn?

A. It is impossible for me to state the whole amount; I burnt hard wood, and I attempted to burn coal.

Q. How much hard wood did you burn?

A. I cannot tell the exact amount; I burnt day and night for several days.

Q. How much moisture was there in the wood; what percentage?

A. It was a little above 20 per cent.; it was dry wood.

Q. What was the wet fuel you burnt in that experiment; how much did you burn?

A. There was burnt in the first place, in 24 hours, 8 cords
378 of peat, containing 65 per cent. of water; in the next place, 4½ cords of peat, containing 62½ per cent. of water, was burned in 24 hours; we have in eight hours' work burnt peat containing 50 per cent. of water, and then the next 4 hours there was an inferior kind of peat used, the percentage of water of which is not given.

Q. Did you measure this peat personally?

A. I did.

Q. How did you personally measure it?

A. I measured it in this way: I had workingmen to measure it for me.

Q. Who were the workingmen who measured it for you?

A. They were employes of the company.

Q. Do you know their names?

A. I do not.

Q. Were you with them when they measured it?

A. I was with them most of the 24 hours.

Q. Can you give us the name of one person who participated?

A. Mr. Burrell, of Buffalo, was my assistant; the others were workmen and I do not remember their names.

Q. You know the measurement, then, only by what they told you?

A. No; I know the measurement; I had vessels of a given capacity, and the peat was measured in those vessels every time it was charged to the furnace; the quantity of water was taken at different

times a day so as to make an average of the amount; our point was to secure as great accurateness as possible in the experiment.

Q. But you cannot tell the amount of wood burned?

A. I kept notes of the amount of wood burned at that time.

Q. Can you tell now the amount of wood burned?

A. I cannot tell now.

Q. Did you ever make any other comparative experiment than this in a Thompson furnace?

A. I tried to burn coal in it.

Q. With what success?

A. I could not burn it.

Q. What is the percentage of water in wet tan direct from the leaches?

A. About 60 per cent.

Q. In your opinion would the wood have burnt better in that furnace if it had 60 per cent. of water?

A. Yes, as I was burning it.

Q. What would be the effect in your opinion of 100 per cent. of water in it?

A. I should think that would be an extinguisher.

Q. At about what point between 60 per cent. and 100 per cent. of water in the wood would be sufficient to put the fire out in a Thompson furnace?

A. I have burnt wet peat containing 75 per cent. of water, without any other fuel to aid me—no dry fuel.

Q. Did this 75 per cent. of water burn better or worse than the 60 per cent.?

A. Worse.

Q. In your opinion is 60 per cent. of water the most efficient proportion in a Thompson furnace?

A. No.

Q. What is?

A. I think that in my practice 50 per cent. is about right.

Q. If you wanted to kindle a fire in a Thompson furnace, and you had 50 pounds of wood in small pieces, would you want it to soak in 50 per cent. of water?

A. I do not say that; no.

Q. Will you state any reason why 50 per cent. of water is the most efficient proportion in a Thompson furnace?

A. I determined it from actual experiment.

Q. Is the opinion you have expressed on that point based on experiment rather than on theoretical science?

A. Entirely from experiment.

Q. When you commenced your experiments had you, as a scientific man, any opinion whether water would aid fuel in a Thompson furnace or not?

A. My opinion was favorable to the burning of wet tan.

Q. Upon whose experiments did you believe it?

A. Thompson's.

Q. Did you have that opinion on the experiment of any other person than Thompson?

A. Weed's, at Binghamton.

Q. Was the experiment at Binghamton made under Thompson?

A. Under Weed, not under Thompson.

Q. Was that among the first of the Thompson furnaces that succeeded?

A. Among the first.

Q. What was your opinion as to whether water would aid combustion before any of these experiments?

A. I had no opinion.

Q. Do you now think that the water in the tan, in a Thompson furnace, either aids combustion or adds a new element of combustion or increases the heat produced, and which of them?

A. What I maintain is that the wet fuel burned in a Thompson furnace is more efficient than dry fuel would be burned in that same furnace; it increases the heat in a Thompson furnace—provided there is a certain percentage of water.

Q. Does water add a new element to fuel; that is, a new combustible element?

A. No; no new element.

Q. What are the combustible elements in the wood that give heat in a Thompson furnace?

A. The union of carbon with oxygen, if dry.

Q. When you add water to dry fuel, and the fuel made with it is burned in a Thompson furnace, do you not claim that the water brings in an element of hydrogen which enters into the combustion?

A. It may play a part in this way, that inasmuch as we have a complex combustion going on, and a sufficiently high heat is maintained—which I claim is the case in the Thompson furnace—to decompose the water into its original elements; we have hydrogen and nascent oxygen, and it may be that there is an advantage in
379 the combustion, as they are more intimate, one with the other, in their combination, in their close alliance, as a matter of mere intimacy; if you have hydrogen present with carbon and oxygen, you have a different kind of combustion going on.

Q. Is that all the answer?

A. Yes, sir.

Q. Did you answer the last question as a chemist, acquainted with what takes place, or as an ordinary observer, guessing at it?

A. It is my opinion of what takes place.

Q. You don't answer as a chemist?

A. I do not.

Q. (By the master.) I understand you to answer from your own experiments and what you saw; is that it?

A. Yes, sir.

Q. As you understand Thompson's patent is it not an essential part of the theory of combustion or heat, on which the patent is based, that wet fuel is more efficient than dry?

A. It is in that furnace.

Q. Then, in your opinion, would it be an infringement of that patent to burn dry fuel in such a construction as Thompson describes?

(Objected to as not tending to throw any light upon the question of profits, which the master is called upon to determine in this case. Objection overruled. Counsel for complainant excepts.)

A. Certainly it would.

Q. Then in your opinion is Thompson's patent a patent for burning dry fuel?

(Same objection, ruling, and exception.)

A. In my opinion his patent is a patent for burning wet fuel, but I maintain if you have a Thompson furnace in this form—

Q. I ask you if that is your opinion?

A. That is my opinion.

Q. Since you don't know how much dry fuel you burned in the experiment you refer to, how can you tell from that experiment which is the more efficient, dry fuel or wet?

A. By knowing how much I burned in a given time, which I have already stated, and the amount of water I evaporated.

Q. Do you know how much dry fuel you burned in a given time?

A. I do.

Q. Did you measure it?

A. I did.

Q. State how much you burned in a given time, and when that given time commenced and ended.

A. I burned two cords of hard wood in 24 hours; that did the work of a ton of coal.

Q. Do you mean to say that in 24 consecutive hours, using that furnace, you burned only two cords of wood without using other fuel?

A. I did in one furnace; one small furnace; without any other fuel.

Q. The same furnace in which you burned the wet fuel?

A. Yes; I built the furnaces one way one year, and then changed them to the way in which wet tan is burned the next year; as they were first built each compartment was small, and the shape—

Q. I only asked you if they were the same furnaces?

A. Yes.

Q. (By the master.) You did not burn the dry wood in the same furnace with the wet peat?

A. I did; then I burned wet peat again the next year; it must have been a very small furnace to burn such a little amount of wood; I tried the experiment of burning wet fuel and dry fuel in the furnace before it was changed and after it was changed.

Q. How much peat did you burn in 24 hours in the furnace in which two cords of wood lasted 24 hours?

A. The furnace that I burned the peat in had two ovens con-

nected together; the furnace that I burned the wood in was a single one; they were small ovens.

Q. That is not an answer to my question. I asked you how much peat you burned in 24 hours in the furnace in which two cords of wood lasted 24 hours.

A. I burned in one of them two cords of wood in 24 hours; I burned in two of them—the first eight hours—peat containing 50 per cent. of water; the last 4 hours of the experiment an inferior peat was used. (Objected to.) The last 4 hours of the experiment 1 56-100 cords of peat were burned.

Q. Have you read Professor Silliman's testimony in this case?

A. No, sir; I have not; only partially; very little of it.

Q. Do you know what he says about water in fuel, and its efficiency?

A. I recollect one remark he made.

Q. You do not know what he said as a whole, then?

A. Oh, no.

Q. You do not claim to be a chemist at all, then?

A. No, sir.

Q. You do not know anything about chemistry?

A. I will not say that.

Q. Coming to Thompson's patent: Do you think any fire in the ash pit is essential to constitute an infringement of Thompson's patents?

A. To have a fire in the ash pit is an infringement.

Q. That is not the question.

A. Not necessarily.

Q. Do you think that more than one feed hole is necessary to constitute an infringement?

A. No.

Q. Is feeding at the top essential to constitute an infringement?

A. I have a belief that it is.

Q. Feeding at the top?

A. Yes.

Q. Is a mixing chamber essential to constitute an infringement of Thompson's patent?

A. Yes, that is essential.

Q. What else beside a mixing chamber is essential?

A. A limited supply of air; and especially so at certain times.

Q. Anything else?

A. The alternate feeding.

Q. Alternate feeding is essential, then, is it?

A. Yes.

380 Q. Tell us how there can be an alternate feed if there is but one feed hole?

A. From the fact that you get the same results from the distribution of a large body of wet fuel, covering surfaces unequally heated, by which the carbonaceous fires are maintained, while distillation of the wet fuel is carried on in other parts of the furnace; and these

gases mingle together and consume each other, just as Thompson practically designed his furnace to act.

Q. Then, in your view, these different degrees of combustion or distillation go on the opposite sides of a pile of tan fed into an oven from one hole, do they not?

A. Yes, sir.

Q. And that whether there is any fire in the ash pit or not?

A. Yes, sir.

Q. Does not the same thing take place in an ordinary coal fireplace, where they burn green wood, and the logs are burned up in the middle before they are burned up at either end?

A. In a furnace it is all burned up.

Q. Does not the same kind of combustion go on?

A. Irregular combustion, of course; some of the carbon is being consumed in one place while the direct distillation is going on in the other.

Q. Please direct your attention to the coal fire before you in this room, and observe that in some parts of the grate there are ashes, and in some parts of the grate coal half burnt, and in some parts of the grate coal blazing on the edge; that that is coal heated and wet, while in other parts of the grate the coal is black—is in another stage of combustion; are there not all stages of combustion in that grate?

A. Certainly there are.

Q. Then why are there not the same elements of combustion to be mixed that there would be in a furnace fed from a single hole?

A. This is a different kind of a fire; the elements are different, in the first place.

Q. If you should throw a little wet tan over this fire and burn it, and it should burn up there in the middle, in the first place, would it not present the same state of combustion?

A. The product is an imperfect combustion—not as perfect as it would be in Thompson's furnace, nor an approximation to it.

Q. Supposing you have a furnace fed from a single hole, which hole is one foot across, and the feeding is continuous, by piling wet tan on top, allowing it to fall through, and there is a grate four feet square, so tight that no tan falls through to burn in the ash pit; there is a passage from the grate, just such a shape as in this chimney before you; that is, it gradually contracts from the width of a grate down to a passage a foot in diameter; the length of that passage or flue is the thickness of the wall on which the boiler rests, and it leads directly under the boiler into an open space there, which is of uniform width the whole length of the boiler, and then there is an opening at the rear end of the boiler, passing into which the heat goes, and goes up the chimney, after passing under the boilers and through them. Now, there are several furnaces ranged side by side, each of that identical construction, but there is no passage from one to the other, and no passage from one flue to the other, nor any passage from the open spaces under one boiler to those under another. The

products of combustion only mingle after they have passed through the flues of the boilers, where they enter the chimney. Would such a construction be an infringement of Thompson's patent?

A. It would.

Q. In the case supposed the fuel passes through the feed hole, falls down upon the grates and burns irregularly about its borders, toward its surface, as fuel burns irregularly in a fire, or at any time when flung upon a grate. Do you still say that the case supposed would be an infringement?

A. I do.

Q. Please state in what the infringement consists.

A. In making a contracted flue for the products of combustion to leave the furnace, for their work you have practically there a mixing chamber; in making your grate so that the fuel does not fall through to the ash pit, you have it so closed that you exclude the air, not accomplish in the furnace what Thompson endeavored to do by a regulated draft.

Q. Then, if I understand you, the infringement consists in these two things: The having of such a contracted flue leading from the furnace under the boiler, and in making the space between the grates so narrow that the fuel cannot fall through, thereby extracting from the amount of air admitted; is there any other infringement than in these two particulars, in the case supposed?

A. No; not in the case supposed.

Q. Referring to the construction which you have last stated as an infringement, state whether it would be an infringement if the grates allowed the fuel to fall through and keep up a fire in the ash pit.

A. I think it would.

Q. Then, in your view, the fire in the ash pit is not an essential part of Thompson's furnace, is it?

A. It can be dispensed with in practice.

Q. Will you state the only part of Thompson's patent that can be dispensed with and still constitute an infringement?

A. The limited exclusion of air, and provision made for a passage from the burning fuel to the boiler, by which the different elements of combustion may have an opportunity of mixing themselves with greater or less perfection of effect.

381 Q. In the case supposed, last referred to, the passage leading from the fire chamber into the space under the boiler is given as being in length simply the thickness of the wall supporting the boiler. According to your view is that flue or passage a mixing chamber within the meaning of the Thompson patent?

A. It is, in part.

Q. Where is the rest of the mixing chamber, except that which the flue constitutes in part?

A. In the arch itself, as built according to the description given.

Q. Which arch; that under the boiler or that over the fire grates?

A. The arch over the fire grates.

Q. Then, in your view, the mixing chamber is in part within the fire chamber and over the grates?

A. It is.

Q. Might not, in your view, the whole of the mixing chamber be within the fire chamber and over the grates?

A. A furnace could be so constructed.

Q. Take the furnace that we have been supposing, and make the passage from the furnace into the space under the boiler only the distance through a piece of cast iron, extending perpendicularly, say an inch thick, would not then, in your view, almost the entire mixing chamber be within the furnace over the grate?

A. It would.

Q. You think such a structure would be an infringement of Thompson's patent, do you?

A. I do.

Q. Then, sir, the question whether there is an infringement, so far as it depends upon the mixing chamber, may be entirely independent of the shape or size of the space under the boilers, which is beyond the termination of the flue we have spoken of, may it not?

A. Yes, sir.

Q. What sort of mixing could take place in the instance you have supposed, where the mixing chamber was almost wholly within the fire grate, which would not take place in the space over an ordinary fire in a fire-place where wood was blazing in the middle and not at the ends, or which does not take place in a furnace under an ordinary steam boiler where soft coal is burning more rapidly on some parts of the grates than on others?

A. In the instance referred to the heat is immediately carried off as made, without regard to the perfection of its combustion; in the case of the furnace I have referred to, in which I stated that a limited combustion chamber exists, a higher perfection of combustion takes place.

Q. Supposing the ordinary country chimney, being about 4 feet wide, has a passage only equivalent to a foot in diameter at the flue leading into the body of the chimney, what then would be the difference?

A. It would depend altogether on the height of the radiating surface over the fire; if that was remote, the effect of confining and permitting the gases to intermingle and consume each other would be very limited.

Q. What do you believe to be the dimensions of what you call the mixing chamber in the case supposed, of a furnace 4 feet square, and where almost the whole of the mixing chamber is within the furnace or fire arch?

A. I would proportion the flue or the mixing chamber altogether to the kind of fuel which was burnt.

Q. We always suppose wet tan, sir.

A. I have in practice governed myself in building these flues.

Q. Never mind about your practice, I only asked what you supposed would be the size?

A. I governed myself by Thompson's instructions.

Q. In your opinion, does it make any difference as to the infringement of Thompson's patent whether the space under the boilers, beyond the end of the flue, is of uniform size, or whether it is large or small, or whether it has bridge walls or not?

A. No; that is immaterial.

Q. Has your experience in the matter of these furnaces led you to that conclusion?

A. It has.

Q. Suppose that the passage under the boilers, in the case supposed yesterday, and to which we have referred to-day, being about a foot in diameter, had continued of that uniform size to the rear end of the boilers, to where the heat passes into the boiler flues to go through the chimney; you get the idea?

A. Yes, sir.

Q. Would there have been equally, in your opinion, an infringement of Thompson's patent in that structure?

A. Not in that especial part.

Q. Do you mean by the "especial part" that there would have been no infringement as to the mixing chamber?

A. No; there would not have been.

Q. Then, in your opinion, if the size of the passage under the boilers is all the way the same as the passage through the fire chamber under the boilers—that is, through the flue—there is no mixing chamber, as you understand it, in the sense of Thompson's patent, and therefore no infringement, so far as the mixing chamber is concerned?

A. So far as that flue can act as a mixing chamber, I admit it.

Q. In such a case would there still be a mixing chamber, in your opinion, over the fire arch?

A. There would.

Q. And there would be such a mixing chamber, even though there was continuous feeding through one hole and but a single fire chamber and a uniform passage, in size, from the fire chamber to the latter end of the boiler?

A. Yes, sir.

Q. Would there be a mixing chamber, in Thompson's sense,
382 supposing the passage from the fire arch and all the way under the boiler was of the same size as the fire chamber?

A. The arch itself is a mixing chamber, as I stated before.

Q. Do you mean, then, that there would be a mixing chamber, in the sense of Thompson's patent, in the case last supposed?

A. I do.

Q. In your opinion, where there is a fire chamber of any usual size, and a passage from that fire chamber leading under the boiler, which passage is very much smaller than the fire chamber, and the space under the boiler to which it leads is very much larger than the

passage, does or does not such a general arrangement inevitably make a mixing chamber within the meaning of Thompson's patent?

A. It does.

Q. Is alternate feeding into such a furnace essential to constitute that mixing chamber, or may feeding through one hole suffice for producing the elements required in the mixing chamber?

A. The feeding through one hole, under some conditions, can.

Q. What are those conditions?

A. The restrictive admission of atmospheric air; an arch thrown over the grate surface sufficiently prolonged for a given body of fuel, and that the proportion is such that the fire can cover the grates when fed in, where those grates are close together, and it is not arranged for keeping up a fire in the ash pit.

Q. What do you mean by the phrase "gases consuming each other"?

A. In complex combustion we have carbon uniting with oxygen, and we have hydro-carbon uniting with oxygen, and they are in different proportions, and they meet and consume each other just as the conditions favor their meeting, when combustion takes place.

Q. But you say you are no chemist, and I understand you never to have made any chemical experiments for a union of these gases; why, then, is your view about that anything more than the merest speculation and guess?

A. Because in matters pertaining to combustion I have been educated sufficiently to answer the above question.

Q. Did you ever make any chemical experiment upon flame, smoke, or what you call the products of combustion from wet tan, so as to determine chemically what they are?

A. Never.

Q. Will you look at some drawings constituting Defendants' Exhibit No. 13, next to page 49 in defendants' exhibit in this case, the drawings being three in number, and state whether you understand those several drawings, and the indicated processes of using fuel by means of the structure there outlined?

(Objected to; objection overruled.)

A. I apparently do.

Q. If there is any part of the drawings which you feel that you do not understand, will you please point it out?

(Objected to on the ground that the witness has already been fully cross-examined in respect to these drawings on giving his testimony for the final hearing; objection overruled.)

A. I suppose that I understand the drawings perfectly.

Q. Would the use of the structure there described in burning wet tan as a fuel be an infringement of Thompson's patent, in your opinion?

A. I cannot tell in looking at the drawing referred to whether that would make an infringement or not, without knowing exactly the provision made for excluding atmospheric air for combustion of the wet tan.

Q. Your attention is drawn to the Model Exhibit 13, of the same structure outlined in the drawing, and your attention is drawn to the fact that there are doors in front into the ash pits for letting in the air, and that the grate bars were so close together that the fuel did not fall through so as to make a fire in the ash pit. In view of these facts, is or is not the construction described an infringement of Thompson's patent, in your opinion?

A. I admit that provision has been made there if they wish to exclude air, and, consequently, that would constitute an infringement.

Q. Then, in your opinion, the construction described in the drawing and exhibit, when the doors are open in the ash pit, would be an infringement, would it not, of Thompson's patent?

A. Provided that the model is a fair exhibit, it would; because those things are too incorrect to judge by, and so are models as a class.

Q. Provided that the drawing is a fair exhibit of that structure would it not be an infringement?

A. It would.

Q. Would it be any more or less an infringement when the front doors into the ash pit were closed than it would when they were open?

A. Not necessarily, providing the grates were close enough together to accomplish the same effect as closing them.

Q. Look at Exhibit 13, and, assuming it is only in a general way correct, assuming that it has such grates that the tan does not fall through and burn in the ash pit, does it not show, over the grate and fire arch, a contracted passage relatively very small, from that fire arch under the boilers, and a bridge wall under the boilers, and the passage of the heat and gases into the rear end of the boiler so as to come within the principles and construction you have laid down as being an essential part of Thompson's patent, to form an infringement?

A. It does.

Q. Your attention is called to two drawings marked Defendants' Exhibit No. 5, in the same volume, next to page 15, in which
383 the Woodstock furnace is represented, and to the supposition that there is no fire in the ash pit, that there is a grate in it allowing burnt tan to fall through, upon which the tan is spread; that there is a contracted passage from that grate under the boilers; that the space under the boilers is of uniform size, being much larger than the said passage, and that the gases enter the rear end of the boiler; will you state whether such a construction is an infringement within the sense of Thompson's patent?

A. It is, if provision has been made to exclude the air.

Q. Exclude the air from what?

A. A restrictive exclusion.

Q. From what?

A. From the fire or its combustion.

Q. Do you mean exclude it from the ash pit, or from the fire chamber itself?

A. From the fire chamber itself.

Q. Then, in your opinion, would it be an infringement when used with the door shut, and not an infringement when used with the door open in front?

A. Depending on how close the grates were together.

Q. You have been told, sir, that the grates were so tight that the tan could not fall through; please answer with reference to that supposition.

A. Then it would constitute an infringement.

Q. When you stated that the Kiersted furnace was an infringement, were you aware that there was only one feed hole continuously fed to that furnace; that the grates allowed no burning tan to fall through, so as to make a fire in the ash pit, and that the products of combustion passed into a passage into the rear end of the boiler, from which there was no connection with the product of combustion from any other furnace or fire chamber?

A. I was aware of those facts; the fuel was fed at certain intervals of time.

Q. Would the question whether it infringed or not, in your opinion, depend on whether it was continuously fed or fed from time to time?

A. No.

Q. When you talk about mixing in such a furnace, I suppose you mean the mixing of all the gases from one side of the fire with all the gases from the other side of the fire, or what comes from the side of the fire with what comes from the center of the fire, do you not?

A. Yes, sir.

Q. Would not such mixing take place whether the fire be two feet in diameter or twenty feet in diameter?

A. Depending upon the other proportions of the furnace entirely.

Q. Describe where this extra oven you have spoken of in the Mosser furnace let in the products of its combustion in respect of the flues from the other fire chambers?

A. A very short distance behind the termination of these flues, the exact distance of which I could not measure, but determined from the wall on the outside, and, admitting that the wall had a certain thickness which I could not measure, the outside thickness of that would be some four feet from the front of the boilers.

Q. In your opinion was the single oven or ovens without that addition an infringement of Thompson's patent?

A. It was, on the grounds I have already stated.

Q. In that case was the mixing chamber, in your opinion, within the fire arch you have described?

A. Not altogether; it was a flue—a contracted flue extending beyond the fire arch.

Q. Was not that flue of uniform size to the rear end of the boiler?

A. No, it was not.

Q. How long was the flue of uniform size?

A. The flue under the boiler was of uniform size.

Q. At its rear end?

A. Yes, but I had reference to the flue coming from the oven under the boiler.

Q. Was not this flue leading under the boilers under the Mosser furnace as wide as the front of the furnace, being more than eight feet?

A. I could not measure it; I got the description of it from Mr. Mosser personally.

Q. Was the length of that flue any more than the thickness of the wall on which the boilers rested?

A. I should judge not from the outside of it.

Q. Shall we understand that your expressed belief that 60 per cent. of water in tan makes it burn better in a Thompson furnace than dry tan would burn in a Thompson furnace rests entirely upon your own experiments, and if not, upon whose experiments does it rest beside?

A. On my own experiments.

Q. Did you ever make an experiment with dry tan or tan pretty nearly dry as compared with wet tan or tan with 60 per cent. of water in the same Thompson furnace, and if so, when and where?

A. I have not.

Q. Did you ever make the experiment of burning dry wood, as compared with wet wood, in the same Thompson furnace, and if so, when and where?

A. I have not, if you speak of wood as containing a large amount of water.

Re-direct examination:

Q. You stated, Mr. Plumb, on your cross-examination, that feeding at the top was essential in considering the infringement of Thompson's patent; just explain what you mean.

A. I mean by that, *important;* that is the sense in which I meant to have the word understood.

Q. When you speak of the furnace to which your attention has been required, as an infringement on Thompson's patent, do you speak of your own observation and practice?

A. No, I do not.

384 Q. I mean from your own observation and practice in reference to such furnaces?

A. No, I have never seen the furnaces referred to.

Q. I mean the furnace to which your attention has been called on the direct examination.

A. I thought you meant these last; I speak from my own observation.

Q. You stated that you had not burned dry wood in a Thompson

furnace; how was it as to dry peat and wet peat; have you burnt those so as to make a comparison between wet fuel and dry?

A. I have burnt peat containing various qualities of water ranging from air-dried peat for several days in hot summer weather up to 75 per cent., and by that means was enabled to determine the effective value of fuel of a given quantity in a Thompson furnace.

Q. You have also burnt dry wood, I think you stated, in the Thompson furnace?

A. What is called dry wood, I have.

Q. You have also, in your experience, burnt dry wood under boilers, have you not?

A. I have.

Q. And burnt coal under boilers?

A. I have.

Q. And you have determined the relative efficiency of these different kinds of fuel from this experience?

A. Yes, sir.

Q. When you speak of dry fuel, you mean dry fuel in the ordinary sense, do you not, in your testimony?

A. I do.

385 *Defendants' Exhibit No.* 1.—October 16, 1874.

EFFICIENCY OF BOILERS.—STATEMENT OF A. FABER DU FAUR.

In regard to the efficiency of boilers, we find, in a "A Manuel on the Steam Engine and other Prime Movers, by William John Macquorn Rankine, London and Glasgow, 1859," the following, on page 290:

"234.—Available Heat of Combustion.—Efficiency of Furnace.—The available heat of combustion of one pound of a given sort of fuel, is that part of the total heat of combustion which is communicated *to the body to heat which the fuel is burned*—for example, to the water in a steam boiler; and the *efficiency* of a given furnace, for a given sort of fuel, is the proportion which the available heat bears to the total heat, when the given sort of fuel is burned in the given furnace.

"The word 'furnace' is here to be understood to comprehend not merely the chamber in which the combustion takes place, but the whole apparatus for burning the fuel and transferring heat to the body to be heated, including ash pit, air holes, flame chamber, *flues*, *tubes* and heating surface of every kind, and *chimney*. The same kind of furnace may be more efficient for one sort of fuel than for another, and it may also be more or less efficient for the same sort of fuel, according to the way in which the combustion is managed.

Page 293.—"The proportion of the whole heat which is lost with the gas discharged by the chimney depends mainly on the *efficiency of the heating surface*, which has already been considered in Article 221.

"Referring to equation 13, in case 2 of that article, let E denote the theoretical evaporative power, E′ the available evaporative power of one pound of a given sort of fuel, in a boiler furnace in which the area of heating surface is S. Then—

$$\frac{E'}{E} = B \frac{S}{S + \frac{ac'^2 W^2}{H}} \qquad (1)$$

Where B is a fractional multiplier, to allow for miscellaneous losses of heat, whose value is to be found by experiment.

"Now, C'^2W^2 is proportional nearly to $F^2V_o^2$, where F is the number of pounds of fuel burnt in the furnace in a given time, and Vo, as in a former article, the volume at 32° of the air supplied per pound of fuel. Also Hx F× a constant. Hence it may be expected that the efficiency of a furnace will be expressed to an approximate degree of accuracy by the following formula:

$$\frac{E'}{E} = \frac{BS}{S + AF}* \qquad (2)$$

in which A is a constant, which is to be found empirically, and is probably proportional approximately to the square of the quantity of air supplied per pound of fuel.

"It is customary and convenient to refer various dimensions and quantities relating to a furnace to the *square foot of grate;* therefore S may be taken to represent the number of square feet of heating surface, and F the number of pounds of fuel burnt per hour, *per square foot of grate.*

"The following are the values of the constants B and A, which have been found to agree best with experiments, so far as the practical performance of boilers has hitherto been compared with the formula:

	B	A
BOILER, CLASS I.—The convection taking place in the best manner (see Article 220), either by introducing the water at the coolest part of the boiler, and making it travel gradually to the hottest (as in Lord Dundonald's boiler), or by heating the feed water in a set of tubes in the uptake; the draft produced by a chimney.....	1	0.5
BOILER, CLASS II.—Ordinary convection and chimney draft.....	1-12	0.5
BOILER, CLASS III.—Best convection and forced draft.....	1	0.3
BOILER, CLASS IV.—Ordinary convection and forced draft..	19-20	0.3

"When there is a feed-water heater its surface should be included in computing S, and the surface of tubes surrounded by water is to be measured outside.

*This formula, and most of the examples which follow it, were first published in a paper read to the Institution of Engineers in Scotland, on the 20th of April, 1859.

"The formula is, of course, not intended to supersede experiments and practical trials, nor to give results as accurate and satis-
386 factory as such experiments and trials, but to furnish a convenient means of *estimating* approximately the evaporative power of fuel in proposed boilers, and *the comparative efficiency of different boilers.*"

The furnaces experimented with at Sparrowbush and Binghamton by Prof. Thurston belong to the second class, where A=0.5 and B=11.12; for the fuel burnt per square foot of grate surface per hour, the quantity of combustible matter must be taken.

The formula (2) for the efficiency becomes for Class II,

$$\frac{E'}{E} = \frac{11\ S}{12(S+0.5F)} \qquad (3)$$

The relative efficiency for one and the same apparatus, or for the same number of square feet of heating surface S, but different number of pounds of fuel 1″ and F″ burnt per hour of square foot of grate, will be,

$$\frac{E'}{E''} = \frac{S+0.5F''}{S+0.5F'} \qquad (4)$$

The formula (3) will be more convenient for comparing experiments in the following form:

$$\frac{E'}{E} = \frac{11}{12\left(1+0.5\frac{F}{S}\right)} \qquad (5)$$

Where $\frac{F}{S}$ = the number of pounds of combustible burned per hour per square foot of boiler surface; the coefficients remain whether F×S be absolute values or referred to the square foot of grate surface, so long as the ratio $\frac{F}{S}$ refers to the combustion per hour.

The annexed table shows for the different experiments at Weed's, Sparrowbush and Laporte the theoretical efficiency and the rate of efficiency (where the actual theoretical value of E, which has not been determined for the fuel in question, does not come into consideration,) and the results of the experiments.

In computing defendants' experiments for the annexed table, the percentage of priming is assumed at 13 per cent., as found by Prof. Thurston at Sparrowbush. Then we have for *Sparrowbush*—

Total heat per pound of steam	1204.80
Total heat per pound of water	138.00
Total heat in 0.869 pounds of steam	1056.97
Total heat in 0.131 pounds of water	18.08
Total heat in 1 pound of mixed water and steam	1075.05
Factor of evaporation $\frac{1075.05}{966.6}=$	1.1127
*Total evaporation at and from 212 degs. $9062\times1.1127=$	10107
Total evaporation per pound of combustible $\frac{10107}{4520}=$	2.24
Water, in fuel, per pound of combustible	1.28
Evaporation, including water in fuel	3.52

For Laporte—In this case the initial temperature of the feed water was 50°, and the amount of heat in one pound of mixed steam and water is $1075.05+(160-50)=1185.5$; the factor of evaporation, $\frac{1185.5}{966.}=1.2265$

TOTAL EVAPORATION AT AND FROM 212 DEGREES.

Experiment No. 4	$19742\times1.2265=24211$
Experiment No. 5	$11022\times1.2265=13543$

	No. 4	No. 5
Evaporation, per pound, of combustible	2.08	2.59
Water in fuel, per pound, of combustible	1.28	1.28
Evaporation, including water in fuel	3.36	3.87

*One cord of tan, as measured, contains 2,000 pounds of combustible.

Comparison of results of furnaces burning spent tan bark.

	Duration of experiments.	Combustible.		Boiler surface.	$\frac{F}{S}$	Theoretical efficiency.		Efficiency by Experiment.			
								Equivalent evaporation at 212 degrees from boiler.		Equivalent evaporation, including water in fuel.	
		Total.	Per hour. F			$\frac{E'}{E}$	No. 2 as unit.	Actual.	No. 2 as unit.	Actual.	No. 2 as unit.
Complainants' experiments.	H. M.	Lbs.	Lbs.	Sq. ft.							
1. Weed's furnace	13 0	17,198	1,323	2,000	0.6615	0.69	1.35	4.24	1.33	5.68	1.29
2. Sparrowbush	9 0	10,051	1,117	700	1.595	0.51	1.00	3.19	1.00	4.41	1.00
Defendants' experiments.											
3. Sparrowbush	3 15	4,520	1,390	700	1.989	0.46	0.90	2.24	0.70	3.52	0.80
4. Laporte	8 15	11,620	1,408	531	2.651	0.40	0.78	2.08	0.65	3.36	0.76
5. Laporte	6 37	5,220	789	531	1.486	0.53	1.08	2.59	0.81	3.87	6.88
	A	B	C	D	E	F	G	H	I	J	K

387 *Defendant's Testimony taken before the Master.*

Circuit Court of the United States for the southern district of New York.

CHARLES N. BLACK, administrator, &c., et al.,
vs.
SAMUEL THORNE et al.

Reference under order of court dated June 8th, 1874, setting aside the report of the Master, and referring the matter back to him.

Evidence of A. Faber Du Faur.

A. FABER DU FAUR recalled on part of complainants:

I have made experiments with tan-burning furnaces at Thorndale, Sept. 5th, 1872, and Sept. 7th, 1872, with furnaces having fire-brick grate bars; also at Laporte, Oct. 18th and 21st, 1872, with furnaces having iron grate bars. I also experimented with a tan-burning furnace at Sparrowbush Nov. 26th, 1872; at the upper tannery. The results of my experiments are submitted in a tabular statement, which I here present, (it is marked Defts' Exhibit No. 1, June 23d, and is offered in evidence.) I consider the results stated in the exhibit to be as nearly correct as can be ascertained by experiments of this kind. As to the boiler surface and grate surface, I had partly to go on information, as I could not well take the measurements while the furnaces were in operation. At Sparrowbush the general foreman gave me the information. At Thorndale and Laporte I took the dimensions myself, with the exception of the boiler surface. As to boiler surface, I had it from Mr. McFarland and Mr. Stormand. I believe the surface to have been properly stated to me. The furnace was the old furnace, against which this suit was commenced. The furnaces at Laporte were the new furnaces, which were put up after the issuing of the injunction. It is a fact well known to engineers that the useful effect of the boiler varies with the evaporation of a square foot of boiler surface; for the experiments of Oct. 18th, 1872, the evaporation was 4.5 pounds per square foot of boiler surface per hour, while on Oct. 21st it was only 3.13 pounds, and this explains the difference in the evaporation per cord of tan. On Oct. 18th the damper of the chimney was open all the time, and air admitted through the side openings of the furnace, and there was more steam raised than was required for running the tannery. On Oct. 21st the damper was so regulated as to get just steam enough for running the tannery. When I made the experiments on Sept. 5th and 7th at Thorndale, it was necessary, as in all such experiments, to determine the exact level of the water at the beginning and at the end of the experiment, and this could only be done by the guage cock, and, to keep up the water level, cold water had to be fed into the boilers during the greater part of the experiments; for this reason the actual evaporation per hour is smaller than it would be during

the ordinary operation of the tannery, when the practice of the engineer was to fill the boiler during the night, sometimes up to the safety valve, and then start in the morning with the boilers full of hot water, and then run without feeding till noon, and feed again during dinner time, and run if possible without feeding till evening; only by conducting it this way could sufficient steam be got to run the tannery. This was not the case with the furnace tested by me Oct. 18th and 21st; I found no difficulty in raising more steam than was necessary to run the tannery, while the water was kept at a nearly constant level. I know that notice was given Mr. Black of the intended experiments at Sparrowbush and Laporte. Mr. Black was present at Laporte when the experiments were made, but was in the office and he may have passed through the tannery, but he did not appear to take any interest in it. The furnace at the upper tannery at Sparrowbush was the same old furnace which I have testified about, and which Silliman and Plumb testified about in the evidence. The tan was thrown in at the front door; there were no feed holes at the top. The pressure of steam in all these experiments was nearly the same—about 50 pounds. I had no means of measuring the temperature of the feed water at Sparrowbush, but, assuming it to have been about 180°, which it cannot possibly have been, and by which assumption the result will be below its actual value, then the evaporation at Sparrowbush per cord of tan at and from 212° will be 4,330 pounds, while the experiment of October 18th at Laporte, reduced to an evaporation at and from 212°, would give 4,111 pounds. I have here compared the Sparrowbush experiments
388 with those of October 18th, because in those two experiments the evaporation per square foot of boiler surface per hour is nearly the same. In the figures in the table no allowance is made for the temperature. If the temperature of the feed water at Sparrowbush had been the same as at Thorndale and Laporte, the evaporation per cord of tan would been have in the column in the tabular statement about 3,600, or more, according to what the actual temperature was; would not have been less than 3,600. To measure the water fed into the boiler, I had a barrel to which the pump was connected, and the quantity of water which the barrel would hold was verified, and then I kept a record of such time a barrel was pumped into the boiler so as to avoid the possibility of a mistake. The water at the beginning and at the end was at the upper gauge cock. I have examined Mr. Plumb's testimony at 579 of the record as to his experiments at Sparrowbush, and his mode of measuring the water is entirely unreliable, because I found that with the same speed of the engine the time required for pumping one barrel full of water into the boiler varied very much so as to make it impossible to come anywhere near the actual quantity of water fed into the boiler by merely counting the number of strokes of the pump. The fuel burned in these furnaces at Thorndale, Laporte, and Sparrowbush, during these tests, Sept. 7th, Oct. 18th and 21st, Nov. 26th, was wet tan from the leaches, no other fuel being used during the

experiment. On Sept. 5th, air-dried tan was used at Thorndale. At Sparrowbush I had no opportunity of weighing the tan, but it came direct from the leaches, and the water would drip out from the bottom of the car in which the tan was taken to the furnaces.

The initial and final conditions of the furnaces were the same at the beginning and end of the experiments for each of the furnaces as near as it could be determined. The Sparrowbush furnaces would require less brick work than the old furnaces at Laporte and Thorndale. The expense for iron grate bars at Sparrowbush would probably be a little more than the fire-brick grate bars at Laporte and Thorndale. On the other hand, the iron grate bars would last the longer. The two kinds of furnaces would be about the same in costs of construction.

I visited the D. T. Stevens tannery at Great Bend, N. Y., and I found there the furnace burning wet tan successfully, and raising all the steam required for the tannery. The furnace was about 8 feet wide by 7 long. It had perforated, convex, cast iron grate bars. The ash pits were cold. The oven was fed from the front through two feed doors. There was a good deal of tan on the ground, showing that they had not burned all the spent tan. As far as I could see, the gases passed directly under the boiler over a fire bridge. The oven was in operation, and I could not see further. There were no feed holes at the top. The combustion was about the same as the Sparrowbush.

Cross-examination:

Have been sworn and examined before in this case on the reference. Do not recollect that I have given these same statements before in this case; have given part of them in an affidavit as far as I recollect; this is the affidavit so far as I can see; it is my signature.

(The affidavit shown to the witness is one of a bundle of affidavits on file in the clerk's office, marked "Filed April 5th, 1873.)

The signature to the deposition now shown me is my signature.

(The deposition is one entitled in the cause taken before R. E. Stillwell, examiner, on the 12th of November, 1872, and marked "Filed Nov. 30th, 1872.")

I do not say that iron will outwear fire brick grate bars absolutely, but that they will outlast fire brick in burning wet fuel, because I have seen them. Have seen iron grate bars remain perfectly cold and in good condition burning wet fuel. If the spaces between the iron grate bars are wide enough to allow half-burned fuel to fall through, and particularly if the distance from the bars to the ash pit is small, the iron grate bars will last but a short time—much less time than the fire brick. If the wet tan does not fall through, the iron will last longer when using wet fuel, such as spent tan, because such fuel burns principally on the surface, keeping the grate bars comparatively cool. I have in several cases raked off the burning fuel at the top, and found that the fuel below would be perfectly black. I profess to be a scientific man on the subject of heat. As such I undertake to state that iron grate bars will last longer than

fire brick where the tan does not fall through. I state this from practical observations. I think I can so state upon scientific principles. The furnaces at Sparrowbush and Great Bend are not identical. The grate bars are different, and the furnaces at Stevens' tannery have two doors, while at Sparrowbush the furnaces have only one door each. No other difference except in dimensions; do not know that the Stevens furnace was originally built to burn coal; have not made any experiments in burning wet tan under boilers; have never carefully examined any burning wet tan under boilers; feeding at the front door requires more labor than at top; combustion is created in the Sparrowbush by the combination of the carbon of the fuel with the oxygen of the air.

Re-direct:

It is my opinion that iron grate bars, as used at the Sparrowbush, will last longer than fire brick as used in a Thompson furnace.

Re-cross:

Under certain circumstances iron grate bars might last only a few days in a Thompson furnace. It depends altogether on circumstances.

DEFENDANTS' EXHIBIT No. 1.—*Experiments with tan-burning furnaces.*

	Weight of one cord of tan.	Duration of experiment.	Tan consumed.	Water evaporated.	Evaporation.			Boiler surface.	Grate surface.	Tan burned per hour per square ft. of grate surface.	
					Per cord of tan.	Per hour.	Per square foot boiler surface per hour.				
Wet tan from the leaches.	Lbs.		Cords.	Lbs.	Lbs.	Lbs.	Lbs.	Sq ft.	Sq. ft.	Cords.	
Thorndale furnaces, Sept. 7, 1872.....	4,568	25h. 10m.	9.00	32,812	3,646	1,303	2.15	601	160	1/447	
Laporte furnaces, Oct. 18, 1872.....	4,375	8h. 15m.	5.81	19,742	3,398	2,393	4.50	531	192	1/273	Steam blowing off all the time.
Laporte furnaces, Oct. 21, 1872.....	4,375	6h. 37m.	2.61	11,022	4,223	1,665	3.13	531	192	1/486	Steam enough to run tannery.
Sparrowbush, Nov. 26, 1872.....	.....	3h. 15m.	2 26	9,062	4,010	2,788	4.29	650	48	1/70	
Air-dried tan.											
Thorndale furnaces, Sept. 5, 1872.....	2,874	9h. 25m.	3.28	21,375	6,514	2,270	3.75	601	160	1/460	

At Laporte and Thorndale, the temperature of the feed water was 50° F.; at Sparrowbush the feed water was heated by the exhaust steam; the temperature was not measured.

Evidence of Charles Cooper.

CHARLES COOPER sworn on part of defense:

I have been once examined in this case; am joint owner of a tannery at Sparrowbush—the one where Prof. Silliman and Mr. Plumb made some experiments on the furnace; became interested in the furnace in 1867, I think; the furnace was very old, also the engine, at that time.

Question. State in what particular, if any, the furnace or engine was out of repair.

(Objected to on the ground that this testimony has already been given by the witness, and appears in defendants' printed record, page 457; overruled and exception taken.)

Answer. The furnace, by long use, had cracks in it so as to let in the air; the cylinder of the engine was worn out of round so as to waste a large amount of steam; when we repaired them last, the furnace was so much burned out that the oven top fell in; we tore out the top of the oven above the grate and rebuilt it the same shape and size as before; we took the cylinder out and had it bored; the man that feeds the ovens takes charge of the engine; the fuel we use in the furnace is wet spent tan direct from the leaches.

Q. If you used any dry fuel in that furnace, state when, how much, and what it is.

(Same objection; overruled and exception taken.)

A. We have a little refuse bark about the mill—small pieces and dust coming from the cars bringing in the bark, which have more or less pieces of bolts and nuts—which is dangerous to grind in the mill; it breaks the mill; we use some of this bark in the morning to light up fires in the morning, and at noon after the fires have been banked; some days when the weather is bright and clear we don't require any; if the refuse stuff was not used for this purpose we would throw it away; the greater part of this stuff is the outside which falls from the bark; it is similar at all mills; we grind sixteen cords a day; use about ten cords of wet spent tan to burn a full day; wet tan is of no use except it is an expense to get rid of it; I think it cost more to build a furnace to feed at the top than at the end; think it requires no more men to feed at the end than at the top.

Q. State how many hides you could tan at your tannery without the use of any other dry fuel than the refuse referred to.

(Objected to as incompetent as calling for an opinion; overruled and exception taken.)

A. Sixty thousand; could tan without any dry fuel or refuse, at least 40,000; in 1872 we tanned 43,300, averaging 20 lbs. dry hides, and

24,000 kips, averaging 11 lbs.; in 1873 we tanned 34,000 hides,
390 averaging 20 lbs., and 33,000 kips, averaging 11 lbs. We are now tanning, when we run on hides averaging 20 lbs., 1,200 hides per week; when we run on kips, 2,000 a week; the only other fuel we use is the refuse which comes from the boiling kettles, which we burn to get out of the way, not because we need it; we use identically the same machinery that we used before; I have no other tannery at Sparrowbush.

Cross-examination:

I received a letter from Mr. Schultz to appear here as a witness; have letter at home, I think; if it is there I will produce it; my expenses as a witness have not been paid to me, nor promised to me; never paid any money to defend this case; don't know who the defendants are; I believe the statements in my former deposition were correct; filled the cracks in the furnace up late last fall; did not tear the furnace down; the top of the ovens burned out, and we repaired them in identically the same form, but better condition; never used a furnace feeding from top; the name of the man who feeds the furnace is Thomas Twist; has been there since last summer; think the name of engineer before him was Carpenter; can't tell the names of all the engineers without looking at books; will look at books and send list; remember we had one named Moses Timbrel; he worked for us; all the men who have worked at the furnace are not in our employ now; can't tell names of persons we buy our hides from without referring to books; all the leather we make is upper leather, except a few damaged hides; am not drying any tan at our tannery now; dried tan last a little over two years ago; we dried it to make new fires to use a little occasionally; no one helps the engineer in feeding the furnace; he has spare time to sit around; throw into the furnace about ten cords in 24 hours; have day and night hand; name of night watchman is Thomas Lahey; run engine part of night, till 11 or 12 o'clock; begin at 7 a. m.; bank up fires from 11 or 12 at night till morning—that is, fill them up with tan; couldn't say how many times he does it.

Re-direct:

If the fires were started earlier in the morning we would not require to use any dry fuel.

Re-cross:

We take the wet tan from the leaches; pitch it out; have two men for this; one man pitches one leach a day, twelve cords; does it in about seven or eight hours, which we consider for him a day's work.

Evidence of David Sweet.

DAVID SWEET, sworn on part of defendants:

Have been examined in this suit; before 1859 I followed building mills principally, flouring mills, saw mills and tanneries; I built the

tannery for Mr. Decker at Wellsburg in 1859, the one I have testified about; the first grate bars lasted, so far as I recollect, about three years; they burned out through the neglect of the fireman in letting the ashes get up to the bars; I have been foreman for Decker at the tannery from the time it was built till about last year and a half; during last year and a half have been in his employ at tannery.

Q. What is now the condition of the grate bars put in about three years after the furnace was built?

(Objected to as immaterial and as this witness has already been called and examined as to this furnace; overruled and exception taken.)

A. They are good; they have been used all that time; we had no fire in the ash pit; the man who feeds the fire attends the engine and pumps; has spare time; draw water from a well ten or twelve feet deep and about seventy feet from engine; pumped from the boiler; we are now tanning at the rate of 10,000 hides a year—very nearly up to full capacity of tannery; not the full capacity of steam power; our hides are sole leather; use no dry fuel except to start the fire; take tan from the leaches; the drawing now shown me represents the front view of our furnace. (It is marked "Defendants' Exhibit No. 1*, June 24, 1874," and is offered in evidence.) The line marked "5" in the drawing represents the top of the passage from the oven to the boiler; the depth between the bottom of the boiler and the mason work below is five inches at the front and eight inches at the rear; the incline of three inches is on the mason work under the boiler, the bottom of the boiler being level; the figures on the drawing, as to figures and dimensions, are correct, or substantially so.

Cross-examination:

Mr. Schultz wrote to Mr. Decker for one of us to come here as a witness; I paid my expenses; have seen an oven nearly like this before, not quite, at Great Bend; do not know what man's name was; saw it in 1859; this oven differed from the Great Bend oven in that the Great Bend oven had what we call a two-foot dead fire; I mean by the "two-foot dead fire" that the bark lays on the brick wall, there being no grates there; never saw any other oven exactly like ours; have seen old-fashioned ovens for baking bread; as near as I can recollect, old-fashioned ovens for baking bread had no grate bars; another difference between our oven and old-fashioned ovens for baking bread was that one was a little smaller than the other, and one might have a little larger door than the other; I have no further statement to make about it.

391 Q. Can you state any other differences between the oven at your tannery and the old-fashioned oven for baking bread?

(Objected to as immaterial; overruled and exception taken.)

*Exhibit No. 1 is a drawing of a Hoyt or Crockett oven, with two feed holes, fed in front—connecting with two boilers with two flues each—and has neither hot ash pit nor mixing chambers. The combustion goes immediately to the shell of the boiler.

A. I don't know of any; no part of our oven was under the boiler; consume from 2½ to 3½ cords of wet tan a day of 24 hours; received about 30 cords a week; tannery is near a stream of water—about 75 or 80 feet from it; take wet tan direct from leaches; carry from 50 to 70 lbs. steam; we don't run night, but keep fire; stop work at 6:30; theory as to what creates combustion is beyond my knowledge; as a general thing tan is kept in leaches eight days; the engineer attends to pumping into the leaches.

Re-direct:

The object in the old-fashioned oven for baking bread was to keep the heat in the oven as long as possible and not let it out. It was the object to get the heat out of our oven and under the boiler.

Evidence of Henry Lampect.

HENRY LAMPECT, sworn on part of defendants:

Reside at Rochester, N. Y., and am a tanner, and have been for 36 years; 30 years ago this summer, in June, in Lockport, at Eastman's tannery, I saw wet tan burned on a grate under a boiler; the same year I saw it in N. Case's tannery in Buffalo; I own a tannery in Rochester and one in Nunda; burn wet tan in the one at Rochester—other not running; one at Nunda was built in 1855; one at Rochester in 1864 and 1865; I made the plans for the one at Rochester and helped build it; the same is now in use; I have two boilers, each 12 feet long and 42 inches in diameter, and 44 2¾-inch tubes in each; the boilers are set side by side, and the grate surface is immediately under the boiler, 7 feet wide and 5 feet deep from the front; the grates are about 22 inches below the boilers, with an ordinary ash pit, with two feed holes, one for each boiler; the feed holes are in front; the front ends of the boilers come forward to the front ends of the grates; the heat goes under the boilers and then passes into the tubes at the other end of the boilers; we have to use something to start the fire; waste and some ross; use no dry wood; after fire is started we throw in the wet tan as it comes from the leaches, with a shovel, through the front doors until we have a good fire started; we run 10 hours a day, but we do not let the fire go out; the grates are made of cast iron and are 5 feet long and semi-circular, with a great many holes extending through; these holes are smaller at the top than at the bottom; besides these I use the ordinary straight grate alternately, that is, one length of straight, then one length of oval, and so on; the straight or flat grate bars are about ¼ inch apart, so as to prevent the tan from falling through; we keep no fire in the ash pit; the doors in front through which we feed are about 18 inches wide and 12 inches high; my grates differ from the ones I saw at Lockport and Buffalo; those were cone grates; I have seen others like mine; I produce by these boilers all the steam I use for the tannery, and for six separate shoe factories, six elevators, one last factory, two machine shops, and, besides, heat all these

buildings with steam; altogether there are ten stores, 241 feet front and 95 feet deep, with basement and four stories above; I never tan more than 500 or less than 300 hides a week; I use from 1,400 to 1,800 cords of bark a year; in the summer I have more wet tan than I can use; in the winter time I use all my tan and also some coal dust; $500 was the most I ever spent in any one winter for coal dust; if I did no extra work outside of the tannery I should produce more wet tan than I could use, and get heat enough for the tannery; one man attends the engine and boilers and does the feeding; in the summer all the other machinery besides the tannery is running; I have another boiler besides the ones I have described; this I use in the winter, principally for heating purposes, and in the summer I burn up the surplus tan in it in order to get rid of it.

Cross-examination:

Am 50 years old; am German by birth; the furnaces I have seen like mine are Bush & Howard's in Buffalo, and same firm in Lancaster, and same firm in Wellsville, and A. Rumsey & Co.'s, in Buffalo; Bush's, in Buffalo; Beidelmann's, in Gaines; Hill's, in Wellsville; Gorglein's, in Palmer; Nash's, in Alden; these are all I remember now. I think I have seen a Thompson furnace; won't be positive of it; have seen a complicated lot of brick work, but can't say whether it was a Thompson furnace; saw the furnaces I have named at different times; some I may have seen 15 years ago and some within a year, and some of them 30 years ago; one of Bush & Howard's I have seen at Buffalo within a year; saw one of theirs at Wellsville some seven or eight years ago; have not seen any of the others within a few years; I go to Buffalo every month; went to Bush & Howard's about a year ago just to see; I saw their old furnace, containing four or five boilers, and saw another which they called an oven furnace; don't know how many ovens it had; saw them put bark in from top; think their old furnace burnt wet tan as well as mine; the old furnace was in operation; did not see any coal in it; couldn't tell how long ago it was that I was at Rumsey's tannery;
did not see an oven furnace there; ross is the outside of hemlock
392 bark, which has no tannin in it; I take the ross off with a machine; I tan green hides, some South American and some Western; tan some sole leather; cannot tell from any fact how much ross 100 cords of bark will produce; it is guesswork; wet tan is not salable in Rochester; hard coal worth from $6 to $6.50; wood from $6 to $8 per cord; don't know the article of dry tan there; don't know what it costs to dry a cord of tan; burn about a leach full of tan a day; my leaches are 6½ feet deep and 10 feet across; are not ground full; put in about 5 cords; have bought coal dust of Alex. Moshier; buy the coal dust in Rochester; think I have bought some of Robert H. Smith; can't name any other parties of whom I have bought; I remember I bought two tons of soft coal last winter, when we had a breakdown, and I could not make any wet tan; bought no hard coal for tannery; have two fur-

naces; I mean to say that I cannot burn all the tan in one furnace; think we have some coal dust left over from last winter; use up the ross as fast as it is made; put it in front of the boilers with the wet tan, and put it in the furnaces; if the engineer uses five cords of wet tan per day he throws it all in himself; Mr. Schultz asked me to become a witness in this case; can't tell when; it was several years ago, when Mr. Schultz and I were talking about it, and I told him I thought the Thompson furnace was a humbug, and that mine was worth ten times as much; have some 60 vats altogether; perhaps 20 used for layaways; all heavy hides tanned into sole leather; tan about same amount of upper as sole.

Re-direct:

Gorglein's and Beidelmann's boilers were like mine; the others were different; I paid for the coal dust $2.38 per ton.

Evidence of Cyrus Whitcomb.

CYRUS WHITCOMB sworn for defendants:

Live at Milwaukee; am a tanner, and have been for twenty-three years; have a tannery at Two Rivers, Wis., and one at Milwaukee; tan at Milwaukee 6,000 hides a month; we built tannery at Two Rivers in 1851; we have record here of hides tanned there from 1859 to 1865; in 1859 there were 24,611; 1860, 24,000; 1861, over 20,000; 1862, over 27,000; 1863, over 25,000; 1864, over 24,000; 1865, over 26,000; this one was an upper leather tannery, and was removed to Milwaukee, and a sole leather tannery was constructed in its place; the furnaces the same way; have tanned there about 20,000 sole leather hides a year since; at Milwaukee tannery use about 8,000 cords of bark a year, and about 4,000 cords a year at the other; use spent tan from leaches for fuel; use no dry fuel in addition except to start fires; use no dry fuel to generate steam; only let the fires go down once in three months, unless some accident happens which makes us stop; takes about one-quarter cord to start fire; same man attends engines and fires; we do not burn all our tan; cannot burn it all; we have all the ordinary machinery, and it is all run by the steam from the boilers; the average weight of dry hides for upper is about 20 lbs.; for sole leather about 25 to 26 lbs. for Western hides; average weight of green upper is from 48 to 55 lbs., and sole 60 to 65 lbs., cured hides; all the furnaces in our tanneries were constructed substantially alike; fed the tan in at the front on to cast-iron grates; the grates were oval shaped, with holes in them; the bottom of the grate presented a wave line; the grates had holes in them ⅜ to ½ inch in diameter; had no fire in ash pit; the holes are in lines about 2 inches apart, and the holes in the lines are about one inch apart, and the separate grate bars come together; the upper surface of the grate ascends from the front to the rear, and then around from the rear end of the grate to the rear end of the boiler; our grate bars are 6 feet; the boilers

are 20 feet; the width of the grate surface at the front is 15 feet; it is all open in one fire-place; two flues in each boiler; we feed these ovens with wet tan, in three separate places; we scatter it as we put it in, and make it as uniform as can be over the surface; the engineer feeds the furnace and takes charge of the engine.

Question. State which would be the more economical, feeding at the top or feeding at the end?

Answer. My opinion would be feed at the front or end. The plan shown me is a fair representation of the furnaces I have referred to; the plan is marked Defts.' Exhibit No. 1, June 30, 1874.

Cross-examination:

This drawing represents the furnaces of both tanneries; these ovens are situated at the front of the boilers; my object in making the grates in the form I have stated is to give a draft all through it; I can't state the proportions of water the tan contains; it might be a quarter of its heft, and it might be less, and it might be more; in my judgment it would be more; I can't say that I ever saw a furnace like the one I use; this furnace is different from an ordinary oven for baking bread; in this the heat and smoke pass under the boiler directly through to the stack under the boiler and through the flue; the bake-oven returns the smoke out of the front end; in this oven furnace there is a side wall; in a bake-oven the arch commences from the bottom; there are two arches sprung in this furnace; in the bake-oven but one; I think the front is not the same; there is a difference in feeding the fire; we feed this on a grate and the other is fed on a brick surface; I think I have stated all the difference that occurs to me; I have seen wet tan burned
393 under a boiler; I think my process is better than that; I am positive it is; I have tried both ways; I heard part of the testimony of the last witness; I don't know that my furnace produces better results than his; it is satisfactory; I am part owner of the two tanneries I have spoken of; it is called the Wisconsin Leather Co.; my company have not paid any money to defeat the Thompson patent to my knowledge; I have never heard of any contract being signed to do so, nor any money asked for; I am not using Thompson's furnace to my knowledge, nor any other kind of furnace but the one I am now using; we run two engines; one is 45-horse power, the other I don't know about; my business is managing the tannery and all the financial business; at Two Rivers I manage a part of the other in connection with the other partners; we don't run the Milwaukee tannery day and night, nor the other either; we stop at half-past six at the Two Rivers, and at six at Milwaukee; we do not take the ross off our bark; we use no wood or shavings in the morning, nor at any time, except when we clean out once in three months; we burn, I think, somewhere near half of wet tan in the Two Rivers tannery, and not as much as that in the Milwaukee; the tan we do not burn we cart off in the swamps at the Two Rivers; at the Milwaukee tannery we sell it at a dollar a load when called for; dry wood I

have known worth from $6 to $7 a cord, and up to $11; at Two Rivers it is worth from 14s to $2; coal I consume in my house is worth from $10 to $11 a ton; I have seen furnaces fed at the top; one in Pennsylvania, on the line of the Philadelphia and Erie Railroad; I think I saw one fed at Wilcox on the same road; it was on the road below Wilcox; don't know who owned the Wilcox furnace; don't recollect ever seeing any others which fed at top; if the tan comes in as it does at our furnace, on a level with the ash pits, it is cheaper to feed it into the front than into a fuel-hole on top; we pitch it with a shovel; shovel in at the Milwaukee furnace from eight to ten cords a day, and at Two Rivers from four to five; the engineer alone does it at Milwaukee; furnace door is about two feet above ash pit.

Re-direct:

Burn the wet tan directly from the leaches.

Q. State whether the passage from the mouth of the oven to the rear end of the boiler, which you have stated constantly narrows, has underneath it a solid mass of masonry.

A. It has.

Evidence of Jas. K. Mosser.

JAMES K. MOSSER sworn for defence:

Reside in Hanover, Lehigh co., Pa.; am a tanner, and have been on my own account since 1854; am thoroughly acquainted with the machinery and business of tanning; our firm had a furnace built for burning wet tan in 1859 and 1860; we commenced to use it in spring of 1860, and have used it up to the present time; had iron grates in it; the grate surface is 8 feet 6 inches by 6 feet; the bars are $\frac{1}{8}$ inch apart and ash pit under; keep no fire in ash pit—that is, there is no combustion there; use wet tan directly from leaches; have doors in front to feed and shovel wet tan in; do not burn all the tan we have; think we throw away from 20 to 30 per cent.; we have to start the fire perhaps three or four times a year—that is, as often as we clean the ashes out under the boilers; use shavings and old wood lying around the tannery for kindling; never bought any wood; think we bought coal once when we were not running; all we bought would not amount to eight tons; we run the machinery and heat the building by the steam; the boilers overlap the grate bars at rear end of grate about six inches; the length of the space through which the heat passes from the ovens to the boilers is the thickness of the wall; the thickness of the wall is not over 13 inches.

Q. State whether the rear wall of the furnace at the point above the top of the grate bars, where this passage is, is not thinner than the same wall below the grate bars?

A. I would not be prepared to say; I was present when the furnace was built; there is an arch over the oven; when we run this

furnace, one man fed the oven, attended the engine and the leaches; in 1860 we tanned 4,100 hides; in 1861, 5,200; 1862, 7,500; 1863, 5,700; 1864, 8,500; 1865, 11,800; we averaged from twenty-three to twenty-five cords of bark to the 100 hides; if the tan is on a level with the oven, I think it is more economical to feed at the front; the plan now produced represents in proper proportions the furnace. (Defendants' Exhibit No. 1, July 1, 1874.) The furnace has worked equally well since 1865; in feeding we put in all we can get in; since 1865, on account of the increase of our business, we have duplicated this furnace.

Cross-examination:

I was brought up as a tanner with my father, and worked with him till 1854; been operating this furnace since 1845 same as before; in 1865 we built another alongside the one we had; the furnaces have no connection with each other; they discharge under same boiler; the two furnaces are similar in all respects, except that in the last one the space through which the heat passes is longer to reach the boiler; we call this space a flue; since 1865 we have averaged 25,000 hides a year; used bark at same rate as before; we tan sole leather; always a sole leather tannery; from the grate bars to arch is from
18 to 21 inches, and we throw in the tan up to the arch;
394 there are two doors to each oven; oven is 8 feet 6 inches wide; one man feeds both ovens and another one besides, which I have not described; this man only makes the fires; since we have had the three furnaces we have one fireman; also have an engineer; the three ovens consume from 15 to 18 cords a day; furnaces are run at night for purpose of burning the tan to get it out of the way; keep a night and day hand for feeding; greater part of surplus tan we cart into the river; third oven is not connected with the others; in that we feed in at the sides; feed it full; it has three doors; it is 12 feet long; when the fireman feeds the oven he feeds in at one door and then at the others as fast as he can; whenever the fire burns down in one place we feed it up; it is not our object to keep the oven full all the time; cannot keep it full all the time, because it burns down; it would not make a hotter fire if we kept it full all the time; if you kept the oven full of wet tan all the time you would not get heat enough; do not think we would get more heat if we fed alternately; we let the fires burn down, but not so low as to have holes through the bars, and then we feed up full; we use this furnace for same purposes that we use the others for; I have seen furnace that fed from top; seen it at Wilcox and several other places; if there is a furnace which feeds itself successfully it would be more economical; in an oven with an arch as low as ours I think it more economical to feed at the side than on top, even if the tan was on top of the oven. I think the work to spread the tan out on the grate after it is run in at the top would be as great as to put it in the sides; I think it requires to be spread out; if you did not spread

it out you would not get any heat; cannot say whether I saw them spread the tan out at Wilcox: if you do not spread it out, then I think it would be less work than throwing in at sides; in 1867 tanned 11,500; 1868, 12,600; 1869, 19,600 hides; think we put in the third oven in 1870 or 1871; we have 141 double layaways and 76 single vats; we have increased the number; in 1865 think we had 64 double and about 20 single.

Re-direct:

Put up the third furnace mainly to get the wet tan out of the way, and I heat my house by the steam; my house is 200 or 300 feet from the boilers; this furnace had some grate bars; had cylinder boilers without flues.

Evidence of Maurice M. Schultz.

MAURICE M. SCHULTZ sworn for defense:

Been examined before; in 1857 I built a set of furnaces at Wilcox, Pa.; are standing now; used them three or four years after put them up; abandoned them for two reasons—1st, because we understood they were an infringement; 2d, because they did not make steam enough; we did not use much dry fuel in them—used a very little; there seemed to be a difficulty in the passing of the heat from the furnaces to the boilers, and hence did not get steam enough; there seemed to be an intense heat in the ash pit, but it did not pass to the boilers; the grate bars were of fire brick, and lasted about two years; they were over one-half inch apart; furnace was erected by John A. Meajley, the same person whom I understood put up Laporte and Thorndale furnaces; the drawing now shown me correctly represents the arrangement and proportions of such furnaces and boilers; (it is marked Defts' Exhibit No. 2, July 1st, 1874;) the grate surface of each oven was 9 feet 4 inches long by 4 feet 6 inches wide; there were eight ovens; each oven was fed from top through two holes each, and it fell in form of a cone; used wet tan directly from leaches; from the rear of the ovens there was a separate flue leading into a common chamber; the rear side of the chamber was formed by a slight wall; this I found to be so when I returned and examined it after giving my testimony before; I was then mistaken; this wall goes up to within about 10 inches of the boiler; the space under the boiler beyond the wall is about 4 feet deep; tan was forked into the fuel holes and formed cones on the grates; there were eight boilers with no flues; where it appears in the drawing that there are flues it is incorrect; found we had not steam enough, and we constructed two more furnaces in 1870; abandoned the use of all these furnaces about two years ago, and erected others about 300 feet from the tannery; I drew the plans; the plan now shown me is a correct drawing of them; (it is marked Defts' Exhibit No. 3, July 1, 1874;) there are two sets of furnaces and boilers connecting with one stack; the grate sur-

face in these new ones is about the same in the aggregate as the eight old ones, which was 336 square feet; in the discontinued ones it is 596 square feet, including the whole ten old furnaces, and in the new furnaces 384 square feet; in new furnaces grates are iron, one-quarter inch apart; have no fire in the ash pit; use wet tan for fuel direct from leaches; do not feed alternately.

(Counsel for complainants objects to any testimony as to this furnace, on the ground that it is shown to have been constructed since the decree was made.

Objection overruled, and the master admits the evidence, as it may apply to the right of the defendants to use it after the time of its construction.

Complainants' counsel excepts; master reserves any other questions as to admissibility of the evidence.)

We have a large quantity of tan lying on top of the ovens, and the feed holes are open, so that, as the tan burns away
395 below, the tan runs in through the feed holes continually; we assist it sometimes when it does not run fast enough; when you look in the tan seems to be in a state of combustion, continuously, over all the cones; there is no combustion in the ash pits; we do not use all our tan—use about two-thirds of it; most of the time the ash pits are so cold that a person can move around in them; there are four feed holes to each oven in a line running toward the end of the boilers; there is a partition between each oven which goes back directly to the rear end of the boiler, and one boiler and a half is heated by each oven, and from rear end of boiler the heat goes back through the flues and then up the chimney; there are no doors on the fronts of these furnaces; we rebuild the fires twice a year, clean out the ashes, &c.; we use wood to start the furnaces; it takes about five cords of slabs twice a year; it is about four feet from the top of the grate bars to the top of the inside of the oven; the passage from the furnace under the boiler is the thickness of a two-foot wall, and that wall is the same thickness all the way down; the passage is of this same size as the oven in shape; the open space under the boiler is all the way of the same size, and no bridge walls; a man can stand up in it; the amount of fuel in these new furnaces is about the same as in the old, and I think we make about one-third more steam, and the new furnaces operate the most continuously and steadily; we drive our machinery and heat the buildings with the steam; I should think the first cost of the two is not much different; the keeping in repair would be less cost in the new, and the new ones are much more convenient in cleaning them out, and much more accessible, and do not have to be cleaned out so often; the ash pits of the new furnaces are 3 feet 9 inches to the bottom of the grate bars; we tan 80,000 hides a year with these new furnaces.

Cross-examination:

I am in partnership with Jackson S. Shultz in the tanning business at this tannery; I never made known until to-day to any one

the correction I have made as to this wall in the old furnace which I alluded to in my direct.

Re-direct:

Q. Referring to Exhibit No. 3 of to-day, state whether there are in your furnaces any such air holes as are indicated in the drawing of the side or top of the furnace, and marked perpendicularly upon the plan?

A. There are not.

Re-cross:

This wall makes a sort of a chamber in the rear of the furnace. We built similar furnaces to the old one; I don't know that the old one is a Thompson furnace; the old one I considered Mr. Hoyt the father of; I had built one similar to it at Sparrowbush, and the same one I sold to Swazey, Cooper & Co.; the same furnace that I referred to when I was examined before; the new furnace is a son of Hoyt, with modern improvements attached; all these furnaces are substantially alike, I think; there are some little variations between the old furnaces and the new; there is a larger throat in this new furnace, and a higher ash pit; no fire in the ash pit; there are sparks; I have been in it; there was some fire in the old ash pit when we used it; I think it is an improvement to have no fire in the ash pit; we seem to get as much heat where there is no fire in the ash pit; our experience in that place is that we get more heat from the furnace having the fire in the chambers above the grate, and no fire in the chamber below the grate—that is, from a furnace having a fire in the chambers both above and below the grate; I spoke of the new furnace having more throat than the old one, allowing the flames to pass directly to the boilers; the cones of tan are a little over four feet in the new furnace, and cover the whole grate; we have four feed holes in each oven, and are feeding continuously; the holes are open, and the tan running in constantly in all four of them. A German by the name of Daniel Dohs built these furnaces.

Q. Look at this drawing marked "Exhibit Dohs No. 1," attached to the affidavit of Daniel Dohs, made in this case March 8th, 1873, and on file in the clerk's office; state whether that is a correct representation of your new furnaces which you have testified about?

A. The furnace may be the same; the ground plan is different; I do not know who made this drawing; I never saw it before; these furnaces have not been altered since they were first put up; these furnace flues communicate under the boiler; we tanned, I think, in the neighborhood of 80,000 hides at our tannery at Wilcox in 1873.

Re-direct.

When I say furnaces are substantially alike, I except the variations I have pointed out.

Evidence of Reuben T. Stevens.

REUBEN T. STEVENS sworn on part of defendants:

Live at Great Bend, Pa., and am a tanner; been such since ——, and have been since 1857 at that place; I had an oven put in to burn wet tan, in fall of 1858; had grate of a surface 7 by 7 feet, iron grates; when I first put them in I had flat grates, but they were too far apart and did not burn good; as soon as it got on fire it would fall through and burn some of it in the ash pits; I took these grates out and put in oval grates, about half round; they were about 10 inches wide, part flat and part oval; both flat and oval surfaces had holes through them; on the under side the holes were about ½
396 inch in diameter, and on the top about ¼ inch, and not to exceed two inches apart; have used these same bars since 1859, and am using them now; have ash pit underneath; no fire in it; feed oven through two doors in front, and cover whole surface from 6 to 10 inches; sometimes it runs down to two; from grate bars to under side of arch is some 20 to 22 inches, and from bottom of bars to bottom of ash pit some 20 inches; use no dry fuel except to start up; I think at one time I run two years without letting my fire go out; would not take over one-quarter cord dry wood to start up if I let fires go out; keep fire going night and day; the wet tan burned is taken directly from the leaches; I burn about two-thirds of what comes from the leaches; have two boilers, what are called flue boilers, two 10-inch flues to a boiler; boilers are 20 feet long and 40 inches diameter; the oven is right in front of the boilers and built right up to them; the shape of the space under the boilers is just the shape of the boilers, and is solid masonry from end to end; my boilers are hung; that the surface of the mason work under the boilers is parallel with the lower surface of the boilers; the space in rear is about one inch in width from the ovens to the rear end of the boilers; the space under the boilers is from 6 to 7 inches; the passage from the arch to the space under the boiler is just the same in size as the space under the boiler; the length of the space between the arch and the space under the boiler is about the width of a fire brick, about 4 inches; I grind my bark, mill my hides, roll my leather, and do all my pumping and heat my dry house in the winter with the steam I make; engine 30-horse power; my engineer tends the engine and feeds the furnace; have no water power and do whole work by steam; tan about 12,000 sole leather hides a year, and use about 2,500 cords of bark; have used my tannery in way I have indicated from 1859 up to this time; first saw oven of this kind at Glenwood, in Pennsylvania; Mr. Lenheim, at our place, built one after mine; am now tanning at rate of 15,000 hides a year.

Cross-examination:

John A. Dusenbury owns an interest in our business, and has for nearly six years; Mr. Eaton was working the tannery at Glen-

wood at the time I looked at it; buy my hides of J. E. Bulkley & Sons; previously bought of Thomas L. Smull & Co.; have 84 to 85 layaway vats; John Curly is my engineer; been with me about twelve years; he was away about six months some seven or eight years ago; during this time he was at Thomas L. Smull's, at Lehigh; on the first grates I used, I think, I burned one or two car loads of coal; never burned it since on the perforated grates; sometimes shovel tan into one door, and then shut it up and shovel into the other, and sometimes into both ovens; the cold air passes up from the ash pits through the ovens; cannot explain how the cold air goes through the tan any further than that we have the doors of the ash pit open, and that makes the draft; when we throw the tan in, generally throw it from 5 to 6 inches thick; sometimes it may be ten, sometimes not more than two; I know that the air goes through the wet tan; the tan lies on the grates there; do not know whether it is a compact body or not; the tan may be 1-16 water, more or less; throw into furnace from 5 to 6 cords of tan a day; run engine night and day; tan we do not use we scrape into the river with a horse; the cone grates work much better with me than the others, because they do not let the tan go through; do not think ever saw cone grates before these, or heard of them till I heard of those of Shapley, who furnished me mine; think they had bar grates at Glenwood; bought my tannery of Silas B. June.

Re-direct:

Have known a Thompson furnace ever since I knew my own tannery; it is within three miles of me; belongs to H. A. Clark.

Q. State the relative working of the two furnaces, that furnace as compared with yours.

(Objected as incompetent and calling for an opinion. Overruled and exception.)

A. I think his makes steam fully as well as mine; he has to stop and cool off before he can clean out; I can clean mine without; I think his engineer is his own fireman; he has to clean his grates, I think, every spring and fall; in stating that there might be 1-16 water it was a mere guess; I burn the tan as it ordinarily comes from the leaches.

Re-cross examination:

Know Clark's furnace is a Thompson because he told me he paid a royalty, and it is built as described; this is the only way I know it; have seen a description of the Thompson furnace in Shoe and Leather Reporter; clean our grates every morning, that is, rake them over.

Re-direct:

Engineer rakes them over.

(Counsel for complainants moves to strike out all witness has stated in regard to the Thompson furnace, on the ground that he

has no knowledge of its being a Thompson furnace except from hearsay.)

The Clark I have mentioned is a brother of Egbert Clark, and they were joint owners of the tannery I have spoken of up to about a year ago.

Evidence of David L. Webster.

DAVID L. WEBSTER, called and duly sworn as a witness in behalf of the defendants, deposes and says:

I am 60 years of age; I reside at Boston, Mass.; business is tanning, currying, and dealing in leather; I was an apprentice at the business when I was 17 years old, and have been engaged in it
397 more or less ever since.

(There was read to the witness the answer to the 13th question of William H. Plumb, a witness on part of complainants, contained on page 547, folios Nos. 1,634 and 1,635 of the complainants' proof in this case, and he is asked to state what were his relations to the furnaces referred to in that answer as constructed at Edgeworth.)

A The firm of Webster & Co., of which I am a member, was and is the owners of the tannery for which those furnaces were constructed; there was no other tannery at Edgeworth; we built the tannery in 1851; I think the furnace referred to in Plumb's testimony was built at the suggestion of Charles Burrill, who represented himself to be the agent of Thompson, the patentee of the furnace; Mr. Plumb was the engineer under whose direction it was put in; Mr. Plumb was selected at the suggestion and in the interest of the agent of the patentee; we were at that time having the same form of furnace reconstructed; Mr. Burrill wanted to get a furnace put in that he might be able to show it as an advertisement; we were to pay the entire expense of putting it in except the engineering; as near as I can recollect, our obligation was to show the furnace to such persons as desired to see it, and to grant them every facility for examining it and noting its workings; as near as I can now recollect, we were not to pay for the patent; I have made a plan of that furnace; this plan is one that was taken by measurement of our superintendent; I saw the furnace in process of construction; was there from one to six hours a day for almost every day during its construction; I supervised its operation from time to time after its construction; this plan is substantially correct; Mr. Plumb superintended, as an engineer, the construction of this furnace; gave the plans and was there from time to time.

(Plan offered in evidence by defendants' counsel, and same is marked "Defendants' Exhibit No. 1, July 7th, 1874. K. G. W., master.")

I have no recollection of receiving any notice of a test that was to have been made on July 31st, 1866; I was there from time to time, in company with Mr. Plumb, after the furnace was completed;

I was there a number of times; I could not state the number; this furnace did not operate successfully nor economically; I think I can say this, that we had continual promises from him from time to time that now it would operate successfully; there were some alterations made on his suggestion between these promises; we were always disappointed as to its working properly; we at last took the furnace out; we took it out in the summer of 1868; we tried to burn wet tan in it; some wood to start it with, and occasionally at other times; the reason we took it out was that it was an unsuccessful and unavailable furnace; we re-set the boilers, and put the furnace underneath it in the ordinary way, with iron grate bars under the boiler, and threw wet tan and a mixture of a little coal dust, waste coal, into the grate bars; under that boiler, when we were driving it as hard as we could, we used about a ton of coal screenings in 24 hours; we were tanning 500 hides a week; the coal screenings cost us from $2.50 to $3.50 per ton; we kept up steam night and day; the substituted furnace, including the coal, was cheaper in its operation than the Thompson furnace; the Thompson furnace would consume two-thirds of the wet tan we made, I should think, and the other boilers which we used at the same time consumed, say, a little more than the other one-third, so that we had to dig up some old tan from the yard; another furnace, which we were using at the same time as the Thompson, was under two cylinder boilers, 28½ feet long and 30 inches diameter, each of them; this was an entirely different furnace from the one which we substituted for the Thompson furnace; we had this furnace running at the same time with the Thompson; the heating surface on the boiler to which the Thompson furnace was attached was, I will say to be safe, more than 1,000 feet; the heating surface of the cylinder boilers, which were running at the same time, was about 250 feet; the same boiler was used in the furnace that was substituted for the Thompson furnace.

Q. Did Mr. Burrill or Mr. Plumb, at any time, claim that the furnace they constructed had not had a fair and adequate trial, or pretend that they could make it any more satisfactory?

(Objected to as immaterial by complainants' counsel. Objection overruled.)

A. They did pretend that they could make it more satisfactory, and from time to time tried to do so; I think they might have found some fault that for the time being there was some mismanagement, but the whole thing was under their direction, and efforts were made to have their views fully carried out; I don't understand that they claimed that it had not had a fair trial; when we took it out I have no recollection of any complaint having been made by either of them on account of its being taken out; there was a furnace constructed for us at our place under direction of David P. Crockett; can't give exact time, but think it was between 1853 and 1855, to burn wet spent tan; the furnace burned wet tan

successfully, but in order to get the entire power of the boilers we were obliged to use some coal screenings; the capacity of the boilers was small for the work we had to do, and we had to drive them.

398 Cross-examination:

The Edgeworth Thompson furnace was erected in 1860, late in the summer or fall; taken out in 1868, as near as I can recollect, in the summer; Edgeworth is in town of Malden, four miles from Boston; last saw Plumb at that place, I think, in summer of 1868; am not willing to state under oath that I have seen him since 1st of January, 1867; I was in Boston and about my business in July, 1866; have no recollection of hearing experiments of Plumb's before yesterday; all I can say is that I have no recollection of it; have same engineer at tannery that we had then; saw a furnace at Sparrowbush before that, but don't know whether it was a Thompson furnace or not; it was a short time before I went there to examine it before I consented to put in the Thompson furnace; don't recollect who owned the Sparrowbush furnace; don't know who told me of the Sparrowbush furnace; don't know whether Mr. Schultz owned that furnace; I have been in Binghamton at Weed's tannery; it was some 10 or 15 years ago; don't think I saw a furnace burning wet tan; it is possible that my brother went there to see this furnace before we put up the furnace; he was in partnership with me at that time; whether he went on purpose to see that furnace I do not know; have no recollection of his going to see other Thompson furnaces at that time; think the furnace at Sparrowbush had four ovens; am not certain; do not recollect whether it fed from top; think there were four feed openings; think it was a sole leather tannery; do not recollect of seeing but one tannery there; our tannery is an upper leather tannery; we tanned at that time from 400 to 500 heavy upper leather hides a week; it was after I looked around and inquired about furnaces that we put the one up at Edgeworth; we must have ground about 40 cords of bark a week; we ran day and night; only for heating during night; kept up two fires; under the two cylinders' boilers we burned wet tan and coal dust; do not dry tan now; we press the water out by a machine; do not think I know why the Thompson furnace did not burn wet tan successfully; we put the Crockett furnace up against the two cylinder boilers—it was somewhere from 1853 to 1855; used it some four or five years; can't recollect exactly about it; then took it out and put fire under the boilers; the reason why we used coal dust with the tan was that we could get better results; we needed all the power we could get out of the boilers, and then had not enough; we could not get the power with wet tan alone that we could when we used coal dust or coal screenings with it; the wet tan did not burn so successfully in that furnace as to give us all the power we wanted; the furnace was put up under the supervision of Crockett himself; I presume we paid him

for it; was not aware that Crockett had a patent; don't recollect that he claimed to have.

(Two letters shown witness and he says:) One of the letters was written by me, the other seems to be written by Mr. Hodges, and I have no doubt I received it.

I made an attempt to burn green salt marsh grass in the Thompson furnace; think it was shortly after we put the furnace in; it was peat and roots of grass, but it had not been saturated with salt water for perhaps ten years before, the water being kept out by a dyke; think it had originally been a salt marsh.

Q. When was the tide dyked off from this marsh?

(Objected to as immaterial and irrelevant. Objection overruled on ground that the answer of the witness as to the marsh being dyked was one not given to any question put by counsel for complainants, but was volunteered by him. Exception taken.)

A. Previous to 1850, when the Boston and Maine Railroad was built.

Q. Under whose direction was this peat put in?

(Objected to on ground that witness has not stated that it was by any one's direction. Overruled and exception.)

A. I cannot answer; I was present and saw it burned, and that is all I know about it; think it was short time after furnace was got under way.

(The two letters referred to by the witness are offered in evidence. Counsel for defendants objects that part of the handwriting of the first letter has been erased, and that the whole paper is to be excluded unless some explanation is given. And counsel further objects to the letter of Mr. Hodges on ground that it is a mere declaration. Overruled and exception taken.)

(The letters are marked Complainants' Exhibit No. 1, July 8th, 1874.)

Think superintendent and engineers were present when peat was put in; whether Plumb or Burrill were there I do not know; think there was dirt or sand in the peat; I attended here as a witness at Mr. Schultz's request.

Re-direct:

I have found dry fuel to be more efficient than wet; I think if our furnace and boiler had been large enough we could have got along without coal dust or coal screenings; the Thompson furnace was 81 feet grate surface, and the Crockett about 36 feet; the Crockett furnace, with the two cylinder boilers, gave us more power than the Thompson furnace with tubular boilers; the boiler surface exposed to the fire in the tubular was more than 1,000 feet; that of the two cylinder boilers was about 250 feet; in relation to the statement in my letter about water in the ash pit, it means that whenever
399 there was a heavy rain some water would come in; the time it remained would depend on the length of the storm; sometimes it would be for three or four days; from the top of the boiler in the

Crockett we took steam for japanning leather; I am a member of the state board of health.

Re-cross examination:

Ground from 20 to 22 cords of bark a week when we used Crockett furnace; in winter time think we used all of it, and in summer about two-thirds; do not think we dried any tan during that period; in my judgment it would make no difference in the amount of heat whether you have a fire under the grate and above the grate, or above the grate alone; or, in other words, so far as my experience goes, the fire under the grate does not add anything to the heat; never made any scientific tests to ascertain the evaporating power of different furnaces.

J. B. Hoyt recalled.

JOSEPH B. HOYT recalled for defendants:

We erected a furnace at Shokan in the fall of 1863; the grate surface was 6 by 16; it burned wet tan from the leaches sufficiently to do all of our work; we tanned from 12,000 to 15,000 hides per year, and were using 2,500 to 3,000 cords of bark.

(Witness is shown a plan marked "Def'ts' Exhibit No. 3," July 1st, 1874.)

The only difference between this plan and the furnace I have spoken of is that the hollow wall or double fire arch in this plan, with the four air inlets, were not in our furnace; what I mean is that our arch was not double, and did not have the holes; I understand this plan to show four feed holes on top; I constructed furnaces like this plan after 1863 at Emmaville in March, 1866; also at Flintstone, in Maryland, in August or September, 1866; at Paw Paw, in West Virginia, in the summer of 1870, and at Ray's Hill the same season; they operated efficiently to make steam sufficient for all purposes for operating the tanneries; all burned wet spent tan; each had single oven except Paw Paw, where we had two sets of boilers and two ovens operating separately; at Ray's Hill tanned from 8,000 to 10,000 hides; Emmaville, from 15,000 to 20,000; Flintstone, from 20,000 to 25,000; and Paw Paw, 25,000 to 30,000 hides; none of these required any dry fuel except to start fires once or twice a year; used at Woodstock furnace from 1,000 to 1,200 cords; the furnace I have testified to before.

Cross-examination:

These are the same furnaces I have testified in relation to in this suit before; do not distinctly remember all I have stated before; all of them feed from the top; I have reference to all the ones I have spoken of to-day; they have four feed holes, except Ray's Hill, which has three; the man that feeds the fire occupies from two to four minutes in feeding all the holes; feeds each hole (successively) at the same time; we feed them as full as they will hold, running down as the natural slope of the tan takes, covering the

grate over its entire surface; for the purpose of removing the ashes in furnaces sixteen feet or more deep, a high ash pit is convenient for going in with a wheelbarrow to remove the ashes; that is the main point of advantage in my mind of a high ash pit; this drawing (Exhibit No. 3) shows one oven; I do not know who made this drawing; my ovens are made on that plan; the first oven that I saw was constructed at the Corner tannery in Ulster county, N. Y.; they constructed it in the spring of 1862; this [pointing to Exhibit 3] is the Hoyt furnace, if I know any such furnace; I know of no reason that it should be called the Hoyt furnace other than the fact that our firm built the first one that was constructed on this plan at the Corner tannery: it was at my suggestion that this style of a double arch was constructed for the purpose of taking the heat radiated through the inner arch, and returning it to the surface of the fire through proper inlets, by letting a limited quantity of the atmosphere through an opening in the outer arch, thereby saving the heat that would be otherwise radiated into the open air, and adding it to the accumulated heat of the furnace, by which the water is more rapidly evaporated and the oxygen furnished for the combustion of the developing gases; I am not aware of having made any other improvement in this furnace; all that section of the arch which is above the grate surface is contained in the double arch, except that portion which is taken up by feed holes; the inner arch is the thickness of the fire brick on the edge; the outer arch may be from 8 to 12 or 16 inches thick; the outer arch runs up to the top of the furnace; I have never built any furnace myself with this style of arch [referring to Exhibit 3]; I have been informed that a number have been built within the last year; the furnaces which I have, and as to which I have testified, have the ordinary arches; by an ordinary arch I mean such an arch as is shown in this drawing, [Exhibit 3,] the arch sprung from the two sides of the furnace, the outside walls built plumb, the space on the top filled in with solid masonry; I do not claim to have made any other improvement in the furnace constructed by me in 1863 at Shokan, except the introduction of air to the surface of the fire; no part of the Shokan furnace was any invention of mine; I made no new device in this Shokan furnace for introducing the air to the fire; I do not claim to have made any invention in any part of the furnaces which I had and of which I have given testimony; I do not burn wet tan in any of these furnaces through any device of my own.

400

D. S. Webster.

The preceding witness, WEBSTER, recalled, by consent, says:

I presume we paid Crockett for the furnace for what he did; I did not mean to be understood that we paid him any license fee.

Re-cross:

Do not think we ever had any license from him.

J. B. Hoyt continues.

Witness HOYT continues:

Exhibit Dohs No. 1 and Dohs No. 2, annexed to papers on file in this case, are shown to witness, and witness says:

Dohs Exhibit No. 2 exhibits the tannery as we had it at Shokan; Dohs Exhibit No. 1 exhibits tannery as we had it at Corner, at Ray's Hill, Pa., Emmaville, Pa., Flintstone, Md., and Paw Paw, W. Va.; only difference between Dohs No. 2 and No. 1 is that in one the furnace is at right angle with the boiler, and other not; no other difference; Dohs Exhibit No. 1 was made under my supervision, by a draughtsman, to represent the furnaces at our tanneries, of which I have testified.

Re-direct:

Q. You are referred to Exhibit Dohs No. 3, and asked if that exhibit, taken in connection with Exhibit Dohs No. 2, does not show two separate furnaces connecting into the same flue or chamber?

A. Yes.

Q. Referring to Exhibit Dohs No. 2, at the points marked "C," "40," "20," and "4½" in red ink, state whether it does not show a flue or chamber broader toward the furnace and narrower for a considerable distance under the boiler, and essentially different from any construction shown on defendants' exhibit July 1, 1874.

(Objected to as immaterial and already answered. Overruled and exception.)

A. It does.

A. Faber du Faur recalled.

FABER DU FAUR recalled for defense.

Have read the opinions of the court in this case; have read the testimony of the witnesses before the master on this reference, and have examined the different exhibits, except "Defendants' Exhibit No. 1, July 7, 1874," and "Def'ts' Exhibit No. 2, 1874."

Q. State whether you find in any furnace described or shown in any of these exhibits the Thompson furnace or any of the essential features of that furnace as explained in the opinion of the court.

(Objected to as immaterial. Overruled and exception.)

A. I do not; I refer to the furnace at Rochester described by Mr. Lampert, the one at Milwaukee described by Mr. Whitcomb, the one in Pennsylvania described by Mr. Mosser, the one at Wilcox, Exhibit No. 3, 1874, and the Stevens, at Great Bend.

Cross-examination:

Q. Look at "Exhibit Dohs Nos. 1, 2, and 3," attached to the affidavits of Daniel Dohs in this case, dated March 8, 1873, and state whether in your judgment those drawings represent a Thompson furnace.

A. In my own private judgment I should not consider them

Thompson furnaces; I understand the difference between a Crockett furnace and one under the boiler to be that one is detached and the other is under the boiler; the expression "detached furnace" explains the whole thing to a man skilled in the arts; this makes all the difference.

Q. Can you state the difference between a Thompson furnace and a Crockett furnace?

A. A Thompson furnace, referring to the revised patents of 1857, requires two or more fire chambers and a mixing flue, where the gases from the different chambers mingle and consume each other, and so operated that the admission of air will be closed, or nearly closed, in the chamber where fresh fuel is charged; the Crockett furnace does not have such a construction and operation; a Thompson furnace may also be made by using a single fire chamber with several grates and ash pits, and charging the several grates in succession, excluding the air from the charged grate until the charge is in a condition for rapid combustion; in the Crockett furnace such a construction and arrangement of different ash pits are not found; as to the Thompson furnace of December, 1857, it is enough to state that the Crockett furnace does not have the hot ash pit; I think it is necessary for a furnace to have all the features I have described to come within his claim; I have seen so-called Thompson furnaces at Weed's tannery, at Binghamton, at the Red Rock tannery, and the furnaces at Laporte and Thorndale decided by the court to be Thompson furnaces; that is all I recollect now; I have never seen those except at the times stated in my previous testimony and affidavits.

Re-direct:

Q. In stating that a Thompson furnace must have all the elements which you have described, did you intend to exclude the idea that a furnace having the equivalents of these elements of the Thompson furnace might be such a furnace?

A. I think not.

Q. In the drawing which you have mentioned as not embracing a Thompson furnace, do you find any such space or resemblance to a chamber as that indicated by the figures and letters "C," "4½," "40," and "20," in red ink, on Exhibit No. 2, and attached to Dohs' deposition?

A. I do not find any chamber; I only find direct passages to the boiler.

Re-cross:

Q. Do you consider it necessary for a furnace to have a hot ash pit to constitute a Thompson furnace?

A. No, I do not; and I do not consider it necessary for a furnace to have two ovens to constitute a Thompson furnace.

401 Circuit Court of the United States for the southern district of New York.

CHARLES N. BLACK, as administrator, &c., and others,
against
SAMUEL THORNE and others.
} In equity.

Exceptions taken by the said complainants to the report made herein by Kenneth G. White, esquire, the master to whom the above-entitled cause was referred, made in pursuance of the decree given on the hearing of the said cause, and bearing date July 1st, 1872.

First exception.—For that the master in his report erred in finding and reporting that the question before him was, whether there was any method, means, or kind of furnace other than the complainants' which the defendants had a right to use and employ, which would produce heat sufficient for the practical use for which the defendants required and used heat, to wit, the tanning of the number of hides which they tanned.

402 Second exception.—For that the master in his report erred in finding and reporting that there were methods and furnaces other than the complainants' and other than those burning dry fuel alone, which would have produced to the defendants equally beneficial results in the way of heat for the purpose for which the defendants used it, and which methods and furnaces the defendants had the right to use.

Third exception.—For that the master in his report erred in finding and reporting that the defendants had the right to use certain furnaces, which he specifies as the Sparrowbush, Crockett, &c.

Fourth exception.—For that the master in his report erred in finding and reporting that the saving to the defendants, or profits made by them by the use of the complainants' invention or furnace over the Sparrowbush or any of the other furnaces, as to which evidence was given before the master, has not been proven by the complainants, and therefore there was no proof before him showing what profit, if any, the defendants have made by the use of the complainants' improvement, and therefore nothing is to be recovered from the defendants in this action.

403 Fifth exception.—For that the master erred in not finding and reporting the amount of profits realized by the defendants as the direct result of the use of the complainants' invention in their tanneries at Albion, Laporte, and Thorndale, and in disregarding the testimony showing such profits.

Sixth exception.—For that the master erred in excluding testimony offered by the complainants on the accounting before him tending to show the profits made by the defendants by the use of the complainants' inventions at their tanneries at Laporte and

Thorndale since the date of his previous report herein, to wit, July 12th, 1873.

Dated New York, December 6th, 1875.

CHAS. N. BLACK,
Sol. for Compl'ts and of Counsel.

Exceptions overruled and report confirmed Jan. 14, 1876.

S. B.

Filed Dec. 7, 1875.

404 [Endorsed:] Circuit Court of the United States for the southern district of N. Y.; in equity; Charles N. Black, as administrator, &c., and another, against Samuel Thorne and others; (copy); exceptions to the master's report; Charles N. Black, sol. for compl'ts.

405 At a stated term of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, held at the United States court-rooms, in the city of New York, on Saturday, the eighteenth day of March, in the year of our Lord one thousand eight hundred and seventy-six—

Present: The Honorable Samuel Blatchford, judge.

CHARLES N. BLACK, adm'r, etc.,
vs.
SAMUEL THORNE et als.

This cause coming on to be heard on a motion for permission to re-argue the matter of the exceptions taken to the master's report therein and to recommit said report to the master—

E. W. Stoughton, esq., is heard in favor of the motion.
Dorman B. Eaton is heard in opposition thereto.

C. A. V.

406 At a stated term of the Circuit Court of the United States for the southern district of New York, held in the city of New York, on the —— day of March, 1876—

Present: Hon. Samuel Blatchford, judge.

CHARLES N. BLACK, as administrator, et al.,
vs.
THORNE et al.

The complainants' exceptions to the master's report herein coming on to be heard, and after hearing Charles N. Black, esquire, for the complainants, in support of said exceptions, and Dorman C. Eaton, esquire, for the defendants, in opposition thereto, it is

ordered that said exceptions be, and the same are, hereby overruled, and that the said report stand affirmed.

SAMUEL BLATCHFORD.

Filed April 4th, 1876.

407 At a stated term of the Circuit Court of the United States for the southern district of New York, in the second circuit, held at the new post-office, in the city of New York, on the 6th day of February, 1878—

Present: The Hon. Samuel Blatchford, judge.

CHARLES N. BLACK, as the administrator, &c., of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, as the administratrix, &c., of WILLIAM P. N. FITZGERALD, dec'd, *ag'st* SAMUEL THORNE, JOHNATHAN THORNE, jr., and JAMES MCFARLANE. } Final decree.

This cause having come on to be heard upon the report of Kenneth G. White, esq., one of the masters of this court, to whom it was referred, to ascertain, and take, and state, and report to the court an account of the gains, profits, savings, and advantages which the said defendants, or either of them, have received since March 31st, 1857, from infringing the exclusive rights of
408 the said complainants, and the said Moses Thompson and William P. N. Fitzgerald in their lifetimes, by the making and the use of the said improvements in each of the said letters patent set forth in the said complainants' bill of complaint, which report was dated the 8th day of July, 1873, and also upon exceptions to the said report on the part of the said defendants and upon the equity reserved, and the said cause having been argued by counsel, and due deliberation had thereon, and the said report having been set aside and the cause sent back to the said master to take further testimony, and the said cause having again come on to be heard upon the second report of the said master, which last-named report bears date the 29th day of November, 1875, and also upon exceptions to the said report on the part of the said complainants and upon the equity reserved, and the said cause having been argued by counsel and due deliberation had thereon, it is—

Ordered, adjudged, and decreed, and this court by virtue of the power and authority therein vested doth order, adjudge, and decree, that there is no proof showing what profits, if any, the
409 defendants have made by the use of the complainants' improvements, and therefore no profits are to be recovered from the defendants herein.

And it is further ordered, adjudged, and decreed that the said

defendants pay to the complainants their costs in this suit as taxed, and that the said complainants have execution for such costs.

SAMUEL BLATCHFORD.

Signed and enrolled this seventh day of February, A. D. 1878.

J. M. DEUEL,
Dep. Clerk.

410 U. S. Circuit Court for the southern district of New York.

CHARLES N. BLACK, adm'r, &c.,
against
SAMUEL THORNE et als.

We hereby consent that the foregoing shall constitute the record to be sent by the clerk of the Circuit Court to the Supreme Court of the United States.

Dated New York, February 26th, 1881.

D. B. EATON,
Of Counsel for Def'ts.
CHAS. N. BLACK,
Sol'r for Compl'ts.
A. J. TODD,
Sol'r for Def'ts.

[Endorsed:] U. S. Circuit Court, southern district of New York; Charles N. Black, adm'r, &c., & ano'r, ag'st Samuel Thorne et al.; consent; Charles N. Black, sol'r for compl'ts. U. S. Circuit
411 Court; filed Mar. 18, 1881; Joseph M. Deuel, clerk.

412 Circuit Court of the United States for the southern district of New York.

CHARLES N. BLACK, as the administrator, &c., of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, administratrix, &c., of WILLIAM P. N. FITZGERALD, deceased,
against
SAMUEL THORNE, JONATHAN THORNE, jr., and JAMES MCFARLANE.
In equity.

The appeal of the above-named complainants and appellants showeth: That on the 11th day of September, 1869, they filed their bill of complaint in the Circuit Court of the United States for the southern district of New York against the said defendants and respondents, in a suit in equity, for the infringement of the patents of Moses Thompson, deceased, for burning wet fuels, and that the said respondents were served with subpœnas issued upon said complaint, and thereupon filed their answer thereto; and such pro-

ceedings were had in the said action that on the sixth day
413 of February, 1878, a final decree was made and pronounced therein by the said Circuit Court, wherein it was adjudged in substance that there was no proof showing what profits, if any, the respondents have made by the use of the complainants' improvement, and therefore no profits are to be recovered from the respondents herein, which part of said Circuit Court is, as these appellants are advised, erroneous and ought to be reversed.

Wherefore these appellants appeal from so much of said decree of said Circuit Court adjudging that there was no proofs showing what profits, if any, the respondents have made by the use of the complainants' improvements, and therefore no profits are to be recovered from the respondents herein, to the Supreme Court of the United States without delay, and that the said Supreme Court will proceed to hear the said cause anew, and that the said part of the said decree of the said Circuit Court appealed from by the said appellants may be reversed and a decree made in respect to the said profits as prayed for by your petitioners in their said bill of complaint, or such other decree as to the said Supreme Court
414 shall seem just.

Dated New York January 26th, 1880.

(Signed) CHAS. N. BLACK,
Sol'r for App'l'ts.

415 [Endorsed:] United States Circuit Court, southern district of New York; Charles N. Black, adm'r, &c., and another, appellants, against Samuel Thorne and others, respondents; appeal from the Circuit Court to the Supreme Court; Chas. N. Black, sol'r for app'l'ts. U. S. Circuit Court; filed Feb'y 2, 1880; John I. Davenport, clerk.

416 Circuit Court of the United States for the southern district of New York.

CHARLES N. BLACK, as the administrator, &c., of MOSES THOMPSON, deceased, and ELIZA W. FITZGERALD, as the administratrix, &c., of WILLIAM P. N. FITZGERALD, deceased, complainants and appellants,
against
SAMUEL THORNE, JONATHAN THORNE, and JAMES McFARLANE.
} In equity.

Know all men by these presents, that we, Charles N. Black, administrator, &c., appellant, and James Salter, of the city of Brooklyn, and William B. Calkins, of the city of New York, are held and firmly bound unto the above-named Samuel Thorne, Jon-
417 athan Thorne, and James McFarlane, appellees, in the penal sum of five hundred dollars, to be paid to the said appellees,

for the payment of which well and truly to be made we bind ourselves and each of us, our and each of our heirs, executors, and administrators, jointly and severally, firmly by these presents.

Sealed with our seals and dated the 26th day of January, 1880.

Whereas the above-named appellants have prosecuted an appeal to the Supreme Court of the United States at the city of Washington, in the District of Columbia, to reverse a part of the decree rendered in the above-entitled action by the Circuit Court of the United States for the southern district of New York:

Now, therefore, the condition of this obligation is such, that if the above-named appellants shall prosecute their appeal to effect,
418 and answer all damages and costs if they fail to make their appeal good, then this obligation shall be void; otherwise the same shall be and remain in full force and virtue.

CHAS. N. BLACK. [L. S.]
JAS. SALTER. [L. S.]
WM. B. CALKINS. [L. S.]

Sealed and delivered and taken and acknowledged before me this 28th day of January, 1880.

JOHN R. WALKER,
Notary Public, Suff. Co.

Cert. filed in N. Y. Co.

UNITED STATES OF AMERICA,
Southern District of New York, } *ss.*

James Salter and William B. Calkins, being duly sworn, says, each for himself, that he is worth the sum of one thousand dollars over and above all his just debts and liabilities.

419 JAS. SALTER.
WM. B. CALKINS.

Sworn to this 28th day of January, 1880.

JOHN R. WALKER,
Notary Public, Suff. Co.

Cert. filed in N. Y. Co.

I approve of the above bond and the sufficiency of the sureties thereto.

Dated January 29th, 1880.

SAM'L BLATCHFORD.

[Endorsed:] United States Circuit Court, southern district of New York; Charles N. Black, adm'r, &c., and another, appellants, against Samuel Thorne and others, respondents; bond on appeal; Chas N. Black, sol. for app'l'nts. U. S. Circuit Court; filed Jan'y 29th, 1880; John I. Davenport, clerk.

420 By the Honorable Samuel Blatchford, one of the judges of the Circuit Court of the United States for the southern district of New York, in the second circuit.

To Samuel Thorne, Jonathan Thorne, jr., and James McFarlane:

Whereas Charles N. Black, as the administrator, &c., of Moses Thompson, deceased, and Eliza W. Fitzgerald, as the administratrix, &c., of William N. P. Fitzgerald, deceased, have lately appealed from a part of a decree lately rendered in the Circuit Court of the United States for the southern district of New York, in the second circuit, which portion of said decree appealed from was made in favor of you, Samuel Thorne, Jonathan Thorne, jr., and James McFarlane, as in said appeal mentioned, and have filed the security required by law:

You are therefore hereby cited to appear before the said Supreme Court on the second Monday of October next, to do and receive what may appertain to justice to be done in the premises.

Given under my hand at the city of New York, in the second circuit, the 29th day of January, 1880.

421 (Signed) SAM'L BLATCHFORD.

[Endorsed:] United States Circuit Court, southern district of New York; Charles N. Black, adm'r, &c., and another, appellants, against Samuel Thorne and others, respondents; citation; Chas. N. Black, sol'r for app'l'ts. I admit service of a copy of the within citation, dated Jan'y 31, 1880; A. J. Todd, sol'r for resp'd'ts. U. S. Circuit Court; filed Feb'y 2, 1880; A. J. Todd, sol'r for compl's.

422 UNITED STATES OF AMERICA, } *ss.*
Southern District of New York, }

I, Joseph M. Deuel, clerk of the Circuit Court of the United States of America for the southern district of New York, in the second circuit, do hereby certify that the foregoing pages, numbered from one to four hundred and twenty-one inclusive, contain a true and complete transcript of the record and proceedings had in said court, as agreed upon by solicitors of record, in the case of Charles N. Black, as the administrator, &c., of Moses Thompson, deceased, and Eliza W. Fitzgerald, administratrix, &c., of William P. N. Fitzgerald, deceased, against Samuel Thorne, Jonathan Thorne, jr., and James McFarlane, as the same remain of record and on file in said office.

In testimony whereof, I have caused the seal of the said court to be hereunto affixed, at the city of New York, in the southern district of New York, in the second circuit, this 17th day of March, in the year of our Lord one thousand eight hundred and eighty-

one, and of the Independence of the said United States the one hundred and fifth.

[SEAL.] JOSEPH M. DEUEL,
Clerk.

[Endorsement on cover:] S. New York, C. C. U. S.; No. 231; Charles N. Black, administrator, &c., of Moses Thompson, deceased, and Eliza W. Fitzgerald, administratrix of Wm. P. N. Fitzgerald, deceased, appellants, *vs.* Samuel Thorne, Jonathan Thorne, junior, and James McFarlane; filed 18th March, 1881.

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Evening Post Job Printing Office, 208 Broadway, N.Y.

SUPREME COURT U.S.
FILED
JAN 19 1884
JAMES H. McKENNEY, Clerk.

Supreme Court of the United States.

OCTOBER TERM, 1883.

No. 231.

CHARLES N. BLACK, administrator of Moses Thompson, deceased, and Eliza W. Fitzgerald, administratrix of William P. N. Fitzgerald, deceased,
Appellants.

vs.

SAMUEL THORNE, JONATHAN Thorne, Jr., and James McFarlane,
Respondents.

BRIEF FOR COMPLAINANTS AND APPELLANTS.

I.—This is an appeal from so much of the decree given in this cause on the 6th day of February, 1878, as adjudges and decrees "that there is no proof showing what profits, if any, the defendants have made by the use of the complainant's improvements, and, therefore, no profits are to be recovered from the defendants herein."

Record, pages 340–342.

The action was brought against the defendants in the Circuit Court of the United States for the Southern District of New York, for an infringement of the reissued Letters Patent of Moses Thompson "for a new and useful improvement for burning tan bark, bagasse, sawdust and other kinds of fuel in a wet state for the purpose of creating heat to generate steam or to be employed in heating or drying operations," dated March 31, 1857. Record, page 77, and extended April 8th, 1869,

Record, page 81.

and for the infringement of the Letters Patent of Moses Thompson "for new and useful improvements in furnaces, for using as fuel bagasse and other carbonaceous substances too wet to be conveniently burned in the usual way," and bearing date December 15th, 1857.

Record, page 83.

Extended December 14th, 1871,

Record, page 88.

The action was brought upon the equity side of the court by the complainants in their representative capacities, the said Black as the administrator of the estate of the said Moses Thompson, deceased, and the said Eliza W. Fitzgerald as the administratrix of the estate of her husband William P. N. Fitzgerald, to whom an interest in said Letters Patent had been assigned by the said Moses Thompson, and alleged that the said defendants had infringed said Letters Patent at the town of La Porte, Sullivan County, Pennsylvania, and at Albion, in the County of Oswego, New York, and had derived and received large gains and profits from the use of said improvements.

The bill prayed for an injunction and account of said gains and profits.

Record, page 1–9.

The defendants by their answer admitted the issuing of the said Letters Patent, but alleged the things patented were known and used before by divers persons and at divers places therein alleged,

Record, page 11,

and that the things patented were described in a large number of printed public works,

Record, page 12.

The answer further alleged that the defendants had not made, constructed, or used the inventions or improvements set forth in said bill.

Record, page 18.

The complainants filed the usual replication to said answer, whereupon a large amount of testimony was taken by the respective parties for final hearing.

Record, pages 20 to 141.

Said cause came on for final hearing on the pleadings and proofs at a stated term of the said court, held on the 21st day of May, 1872, and was continued until the 27th day of May, 1872.

Record, pages 142, 143.

On the first day of July, 1872, the court gave its decree, whereby it was adjudged and decreed "that said Letters Patent are good and valid patents, and that the said Moses Thompson, now deceased, was the original and first inventor and discoverer of the improvements, described and claimed in said Letters Patent. That the said complainants had become possessed of and vested with the sole and exclusive right of constructing, using and vending to others to be used the said improvements during the periods of said Letters Patents and said extensions."

"That said defendants have infringed upon the exclusive rights of the complainants, under each of said Letters Patent and said extensions, by making and using furnaces containing the improvements claimed and described in each of said Letters Patent," and further decreed "that the complainants do recover of the defendants the profits, savings, gains and advantages which the said defendants have received or made or which have accrued or arisen to them from said infringement of said Letters Patent, and their said extensions, by the making, sale and use of the

improvements described in each of said Letters Patent, and further decreed "that it be referred to a Master to take and state and report to the court an account of such gains, profits, savings and advantages" "and that a perpetual injunction be issued against the said defendants, according to the prayer of the bill."

Record, pages 155–156–157.

Testimony was given before the Master on said accounting as to such gains and profits, commencing October 31, 1872.

Record, pages 160–176.

The Master made his report upon said accounting, dated July 12, 1873, whereby he found and reported "that the complainants are entitled to receive from the defendants as profits made by them from the infringement of the patented invention upon which this suit is brought, the cost or value of all the wood, which but for the use of said patented invention they would have burned in the tanneries owned and operated by them, and referred to in the bill of complaint.

That the total amount due the complainants on the 2d day of July, 1873, including interest, was $44,975.49.

Record, pages 157–160.

Exceptions were taken by the said defendants to the said report of the Master.

Record, pages, 176–178.

The said exceptions came on for hearing at a stated term of said Circuit Court, held on the first day of April, 1874.

Record, page 178.

And on the 8th day of June, 1874, it was ordered that the said report of the Master, dated on the 12th day of July, 1873, "be, and the same is hereby set aside, and the Master proceed to take further evidence under the original order of reference to him," &c.

Record, page 181.

Whereupon, on the 5th day of October, 1874, the said Master did proceed to take further testimony in pursuance of said order.

Record, pages 184 to 337.

And after said testimony was concluded the Master made his report, dated November 29, 1875, whereby he found and reported "that there is no proof before me showing what profits, if any, the defendants have made by the use of the complainants' improvements, and therefore nothing is to be recovered from the defendants in this action."

Exceptions were filed by the complainants to the said last named report of the said Master, December 7, 1875.

Record, pages 338, 339.

The court, after hearing said exceptions, overruled the same, and confirmed said report.

Record, page 339.

And on the 6th day of February, 1878, a final decree was entered herein, whereby, among other things, it was ordered, adjudged and decreed, "and this court, by virtue of the power and authority therein vested, doth order, adjudge and decree that there is no proof showing what profits, if any, the defendants have made by the use of the complainants' improvements, and therefore no profits are to be recovered from the defendants herein."

Record, page 340.

From so much of said decree as above set forth, the complainants appealed to this court.

Record, page 342.

II.—The contest and the patents are very minutely stated in the opinion of the court on the final hearing.

Record, pages 144, 145.

The court held: "Fire chambers in a series, communicating with a common flue, existed before, but the patentee's process was not carried out in any of such prior struc-

tures, nor was such common flue used as a mixing chamber in any of them. The first claim of the reissue is for a process carried into effect by an apparatus. The prior apparatus would not have enabled the patentee to work his new process, nor was such new process ever worked before in any apparatus.

The second claim of the reissue is for an apparatus when employed to work a process, the apparatus and the process being both of them new with the patentee. It is not perceived how any tenable objection can be taken to the validity of either claim. The disclaimer does not admit that the patentees arrangement existed before, although he disclaims it irrespective of the purpose and manner of his use of it."

Record, pages 149 and 150.

The court further held :

The principle developed in the first claim of the reisssue of 1857 is worked out in the furnace and method of procedure described in the patent of 1857, but the claims of the two patents are different. The claims of the patent of 1857 are for special constructions to work out more effectually the process of burning wet fuel discovered by Thompson, and made known in his original patent of 1855. The first furnace constructed by Thompson on his principle was built at Richmond, Va., in August, 1853, and was then and there used successfully in burning wet tan. In 1854 he built a furnace on his plan at Weed's tannery at Binghamton, N. Y. Others were built after its pattern at various places in New York, and the furnaces used by the defendants are traced in their origin to the furnace so built at Binghamton. It is very manifest from the language of Thompson's specifications, and from the testimony, that the form of apparatus shown by Thompson in his drawings, and described, admits of many formal variations within the principle of his inventions and the scope of his claims. Thus, a single furnace, with an upper chamber and a lower chamber, separated by a grate, and sufficiently long to admit of two feed holes in the top, with a proper mixing chamber, and operated so as to produce in such chamber the mingling and consumption of the gases from the wet fuel in the upper chamber with the gases from carbonaceous combustion, would infringe the first claim of the reissue of 1857. Such a construction, with the lower chamber used for the combustion of dry

carbonaceous fuel, and so operated as to cause the gases from both chambers to be continuously and simultaneously discharged into the mixing chamber for mingling and mutual combustion, would infringe the first and third claims of the patent of 1857. A single furnace, with the grate between the upper and lower chambers so open as to allow the lower portion of the wet charge, as dried and charred, to fall through into the lower chamber, and keep a hot fire therein, the uncharred portion of the wet charge being supported by the grate, would infringe the second claim of the patent of 1857. So, also, various constructions of mixing chambers may be made, which would be substantial equivalents for the mixing chamber of the form and location shown by Thompson, and would be the mixing chamber of each of his two claims in the reissue of 1857, and of the first and third claims of his patent of 1857.

It is satisfactorily shown that the wet tan furnaces of the defendants in their tanneries at Albion, Laporte, and Thorndale, which are the three proceeded against, infringe each of the patents. All of the claims of each patent are infringed by the furnaces at Albion and Laporte; and all, except perhaps the second claim of the reissue of 1857, are infringed by the furnace at Thorndale.

The claims of the Thompson patents are none of them successfully attacked on the ground of a want of novelty. There is nothing in the Crocket furnace, or the Morrison furnace, or the Woodstock, Sparrowbush or Newark furnaces, or any of the other American furnaces adduced in evidence, so far as such furnaces are shown to have existed in construction, or in description or drawings, before the dates of Thompson's inventions, which destroys the novelty of those inventions. So far as such furnaces burned wet fuel successfully before Thompson's inventions, to what extent they did, they did so on different principles from those developed by him, and in structures arranged and operated in a manner not embraced in his claims. In regard to all the foreign patents and publications put in evidence, it is sufficient to say that none of them anticipate Thompson's inventions. It is not an unimportant consideration that both of his patents have been extended by the Patent Office, after, as there is every reason to believe, a full consideration of substantially everything on the question of novelty that is brought up in defense in this suit.

It is apparent from the evidence that Thompson was the first to discover and put in practice the true method of economically burning wet fuels, and obtaining from them better results than from equal quantities of dry fuels. In

respect to the tanning business, tanners can, by his inventions, certainly obtain all the heat they need by the use of no other fuel than their spent tan, wet from the leaches. The combined resistance by them to his patents is a tribute to the merits of his inventions.

I have examined with care all the evidence taken in this case, and considered the views advanced by the counsel for the defendants, but I am unable to resist the conclusion that the plaintiffs have fully established their case.

Record, pages 154–155.

Black Adm. *vs.* Thorne, 5 Fisher, Patent Cases, 550.

III.—The Master, in his first report, found and reported,

"*Second.*—That the proofs taken before me on part of the complainant, and not contradicted or disproved on the part of the defendants, show *that the saving of wood to the defendants by the use of said patented invention was one cord of wood for every ten hides tanned by them, less* 100 *cords per year for a tannery tanning* 15,000 *hides per year, and a like proportion for a tannery tanning a less number of hides; also, ten cords per year for each tannery, used in the starting of fires.*"

Record, page 157.

This report was set aside by the court, and the Master was directed to take further evidence, "addressed to the question of the gains or profits made by the defendants in producing heat from burning wet tan, by the employment of the patented improvements at the defendants' tanneries, over and above the gains and profits they would have made by the use to produce equally beneficial results in the way of heat of another method for producing such equally beneficial results open to them, to be used at the time they used the patented improvements, and that the Master, as to any particular not above defined, be guided by the views set forth by the opinion of this court, given

on the decision as to such exceptions, and filed April 28, 1874,"

Record, page 182.

IV.—After taking such testimony as was offered by the respective parties, the Master reported :

"If the expression of the court in its decision—'*equally beneficial results in the way of heat*'—is to be understood to mean an equal *degree or amount* of heat, then the Master is of the opinion, and finds from the evidence in the case, that no other than dry fuel could produce such *equally beneficial results in the way of heat.*"

"But the Master does not so understand or interpret the language or intention of the court. The question before him is, as he understands it, was there any method or means or kind of furnace other than the complainants' which the defendant had a right to use and employ, which would *produce heat sufficient for the practical uses for which the defendants required and used heat*, to wit, the tanning of the number of hides which they tanned. The Master finds and reports that there were methods and furnaces other than the complainants', and other than those burning dry fuel alone, which would have produced to the defendants "*equally beneficial results in the way of heat*" for the purpose for which the defendants used it, and which methods and furnaces the defendants had a right to use."

Record, page 183.

V.—To this report the complainants excepted as follows :

"First exception. For that the Master erred in finding and reporting that the question before him was whether there was any method, means or kind of furnace other

than the complainant's which the defendants had a right to use and employ which would produce heat sufficient for the practical use for which the defendants required and used heat, to wit, the tanning of the number of hides which they tanned.

Second exception.—For that the Master, in his report, erred in finding and reporting that there were methods and furnaces other than the complainants', and other than those burning dry fuel alone, which would have produced to the defendants equally beneficial results in the way of heat for the purpose for which the defendants used it, and which methods and furnaces the defendants had the right to use.

Third exception.—For that the Master, in his report, erred in finding and reporting that the defendants had the right to use certain furnaces, which he specifies as the Sparrowbush, Crockett, &c.

Fourth exception.—For that the Master, in his report, erred in finding and reporting that the saving to the defendants, or profits made by them by the use of the complainants' invention or furnace over the Sparrowbush or any of the other furnaces, as to which evidence was given before the Master, has not been proven by the complainants, and therefore there was no proof before him showing what profit, if any, the defendants have made by the use of the complainants' improvement, and therefore nothing is to be recovered from the defendants in this action.

Fifth exception.—For that the Master erred in not finding and reporting the amount of profits realized by the defendants as the direct result of the use of the complainants' invention in their tanneries at Albion, Laporte and Thorndale, and in disregarding the testimony showing such profits.

Sixth exception.—For that the Master erred in excluding testimony offered by the complainants on the accounting before him, tending to show the profits made by the defendants by the use of the complainants' inventions at their tanneries at Laporte and Thorndale since the date of his previous report herein to wit, July 12, 1873."

VI.—The findings of the Master in his report embraced in the first three exceptions of the complainants were immaterial, inasmuch as they did not show, or pretend to show, the profits made by the defendants by the use of the complainants' invention. The testimony offered by the defendants was objected to by the complainants as immaterial and incompetent.

Record, pages 163, 165, 166 and 114.

The defendant must account for the profits.

U. S. R. S., Sec. 4921.

VII.—The report of the Master embraced in complainants' fourth exception, finding and reporting that the savings of the defendants, or profits made by them by the use of the complainants' invention or furnace over the Sparrowbush, or any other of the other furnaces as to which evidence was given before the Master, has not been proven by the complainants, and therefore there was no proof before him showing what profit, if any, the defendants have made by the use of the complainants' improvements, and therefore nothing is to be recovered from the defendants in this action, is erroneous. If any such proof was necessary or proper, it should have been furnished by the defendants; the burden was on them; but such a finding could not have affected the complainants' claim for the profits made by the defendants from the use of complainants' invention.

Elizabeth *vs.* Pavement Company, 7th Otto, 126–141.

VIII.—The defendants made their profits by the improper use of the complainants' invention. They must account for the profits realized as the consequence of such use—such profits as they received as the direct result of its use.

Littlefield *vs.* Perry, 21 Wallace 205–229.

IX.—No testimony was produced by the defendants to show that they did not realize the profits claimed and shown by the complainants, and confessedly by the use of their invention, but they undertook to show, against the objection of the complainants, that by the use of some other furnace, open to the public, they might have made the profits, or some proportion of them, which they realized in the use of the complainants' invention.

It is a sufficient reply to this proposition, as said by Nixon, J., "to observe that the defendants preferred and used the complainants' property, and made their gains therefrom, and that these gains no less belonged to the complainants, because they might have realized other gains by the use of lawful modes."

The American Nicholson Pavement Company *vs.* the City of Elizabeth, 6th Official Gazette, 764, 770.

And in another case Nixon, J., says: "Surely the defendants are not permitted to get rid of the consequences of a confessed infringement by alleging that they might have used some other machine as advantageously as the complainants'."

Emerson *vs.* Simm, 6 Fisher Pat. Cases, 281, 285.

And it was said by Blatchford, J.: "On the hearing, the defendants' counsel did not dispute that if the saving of the lime sulphuric acid and fat was due to the use of the plaintiff's process, the plaintiff was entitled to the value of such saving. That is undoubtedly a correct principle as applicable to an accounting for profits in a case of this description in equity."

Tilgeman *vs.* Mitchell, 4th Fisher Pat. Cases, 599, 613, 614.

X.—Thompson's furnace was a complete combination in itself, differing from every other furnace. The court held: "Fire chambers in a series, communicating with a common flue, existed before, but the patentee's process was not carried out in any of such prior structures, nor was such common flue used as a mixing chamber in any of them. The first claim of the reissue is for a process carried into effect by an apparatus. The prior apparatus would not have enabled the patentee to work his new process, nor was such new process ever worked before in any apparatus. The second claim of the reissue is for an apparatus when employed to work a process, the apparatus and the process being both of them new with the patentee."

Record, pages 149–150.

Thus combined and arranged it made a new thing, like a new chemical compound. It was this thing, and not another, that the people wanted and required. It was this that the appellees used, and by using made their profit, and prevented the appellants from making it.

Elizabeth *vs.* Pavement Company, 7th Otto, 126, 141.

XI.—None of the furnaces referred to by the court below as the "Crockett furnace, Morrison furnace, or the Woodstock, Sparrowbush, or Newark furnaces," or any of the other American furnaces adduced in evidence, antedate Thompson's invention. Joseph B. Hoyt, one of the defendants' principal witnesses, fixes 1853 as the time they were first built.

Record, p. 98–99.

Before that he says tanners, who were using steam as a motive power, were using wood.

Record, p. 102.

Thompson's caveat was filed August 12, 1853.
Record, page 74.

In that year his furnace was in successful operation.
Record, page 20.

XII.—The 1853 furnaces, to which Hoyt alludes, did not burn wet tan successfully. They used wood, coal and dry tan mixed with wet tan.
Record, pages 36, 42, 43, 47, 64, 91, 129, 130, 168, 188.

Professor Silliman describes the operation of the Sparrowbush furnace as he saw it :

"The furnace appeared to me to be one of ordinary construction, with open ash pits, differing in no respect, so far as I could observe, from ordinary furnaces attached to steam boilers, except in the feature of a low arch of brick work over the combustion chamber. The combustion was exceedingly imperfect, producing but little heat and considerable smoke. The grate bars were set quite close together, and were of iron. After the products of combustion left the combustion chamber, they were delivered under the shell of each boiler and returned by flues through the boiler, and so back to the chimney. I learned that these two furnaces burned about ten cords of tan for twenty four hours, and I observed that they required attention from the firemen for stoking and regulating the fire once in about fifteen minutes.

"At the lower mill of the same establishment I found a similar furnace ; a single one, newly constructed, and acting upon a single boiler. It appeared to me to be in all respects similar in construction, in action, and in the condition of the fuel, to that which I have already described as witnessed in the upper furnaces. The tan upon the grate bars, which were of iron, was black and smouldering, with a few bright spots here and there. No use was made of the ash pit as an incineration chamber, the door of the ash pit being wide open. These furnaces showed to me no similarity in their mode of action, or in their essential

construction, to the furnaces of Moses Thompson, and are to be considered as only very imperfect and unsatisfactory means of utilizing the fuel which they consumed. The temperature of no part of these furnaces, as I saw them in action, was adequate to enable them to act as do the furnaces of Moses Thompson, nor, in my opinion, would they act at all economically unless they were supplied with a portion of dry wood, or other fuel, to aid in preparing the tan for combustion."

Record, pages 64, 65.

Their inefficiency is also demonstrated by Professor Thurston:

"Comparing the furnaces examined, I came to the conclusion that the most efficient result in burning wet tan is secured by a system in which the fuel is charged alternately through two or more openings into the furnace, is then surrounded by masses of highly-heated brickwork or other slowly conducting material, at the same time being exposed to heat radiated from fuel burning beneath it, and to the action of heat brought into the mass by the streams of heated gases rising from this latent mass of fuel, and also by the thorough intermixture of products of combustion with those of distillation; I concluded that a less degree of efficiency would be obtained in any case in which any one of these requisites was not secured; that tan might be burned, although with comparatively low efficiency, in a furnace differing from the ordinary steam boiler furnace, only by the possession of some one of these special provisions. I concluded that one of the most important of these provisions was that called the incineration chamber; I concluded, however, that no reliable comparison between any two types of furnace could be made, except by experiment; I therefore subsequently took advantage of the first opportunity, and made a careful experimental determination of the efficiency of the Weed furnace at Binghamton as a good representative of the Thompson type of furnace, and of the furnace of Swazey, Cooper & Co., at Sparrowbush."

"25. The second furnace was of the form known as the 'Crocket furnace.' It has very little to distinguish it from the ordinary forms of furnace.

"In this example two furnaces were constructed side by side, each having a grate surface of four by six feet, the total grate area of both being 48 square feet.

"The grates were of cast iron, of ordinary form, set so

closely that none of the wet fuel could fall through into the ash pit. It was stated that it was not intended that the charred fuel should fall through and burn in the ash pit. During this trial, however, more or less burning tan was continuously falling into the ash pit, and burning there, it undoubtedly assisted, in some degree, in the dessication of the wet fuel by direct radiation of heat, and by heating the entering air as it passed over this bed of hot coals.

"To this extent the furnace resembled the Thompson furnace already described."

"41. Comparing this result as a standard with the evaporation obtained in the two wet fuel furnaces, per pound of fuel exclusive of water, we get for the Thompson furnace $5.68 \div 4.69 = 1.21$, and for the Crockett $4.49 \div 4.69 = 0.94$.

"The Thompson furnace is thus seen to have given a better result per pound of ligneous combustible when burning wet tan than was obtained in the ordinary steam furnace burning seasoned yellow pine, this superiority reaching 21 per cent.

The Crockett furnace had 94 per cent. of the efficiency of the common wood-burning boiler furnace."

Record, page 187, 196, 199, 200.

The above statements confirm the engineers who worked these Crockett furnaces.

Record, pages 41, 42, 44.

Robert Dingwell said they used "from 1,000 to 1,200 pounds of bituminous coal in 24 hours."

Record, page 47.

JAMES FREEMAN testified:

"I have been the engineer of the tannery formerly owned by Hoyt & Ladue, at Grayville, Herkimer County, N. Y., for ten years past, except one year when I was absent. When I went there in 1862 they had a short oven in which they burnt wet tan; it fed from the front door; we were very seldom able to keep up steam by burning wet tan alone; we had to use some wood with it; steam run down when we didn't have wood, so that we could not run the machinery."

Record, page 168.

XIII.—The appellants are entitled to a decree for the amount found due by the Master on the first accounting.

CHAS. N. BLACK,
Of Counsel for Appellants.

111-122

OFFICE SUPREME COURT U. S.
FILED
JAN 21 1864
JAMES H. McKENNEY, Clerk.

Supreme Court of the United States.

CHAS. N BLACK, ADMINISTRATOR OF MOSES THOMPSON, DECEASED, &C., (PLAINTIFFS AND) APPELLANTS,

against

SAMUEL THORNE, JONATHAN THORNE, JUNIOR, AND JAMES McFARLANE.

APPEAL FROM THE CIRCUIT COURT OF THE UNITED STATES FOR THE SOUTHERN DISTRICT OF NEW YORK.

Brief of Mr. Eaton on behalf of the Appellees, who are the Defendants in the case.

I.

1. Moses Thompson, the assignor of the plaintiff, was the inventor of two devices for burning wet fuel, &c., in furnaces. One was patented in 1855, and there was a reissue in 1856. The other was patented in 1857. (Record, p. 3 to p. 5.)

2. The defendants are charged with infringing these patents at three places, viz., La Porte, Pa., Albion, N. Y., and at a place called Thorndale, by the use of the patent device in furnaces for burning wet tan-bark for supplying heat at tanneries. (Record, p. 8 and p. 158.)

3. The court below held that the defendants had infringed the patents, and ordered an account of the profits made by them to be taken before a referee. (Record, p. 155 to 157.)

4. The report declared that large profits had been made by the defendant which should be recovered by the plaintiff. (Record, p. 157 to 161.)

5. This first report was set aside and a new accounting was ordered upon a different basis. (Record, pp. 181 and 182.)

II.

The questions of fact arise mainly out of the evidence taken on the second accounting; and the questions of law are wholly those connected with the instructions of the court setting aside the first report and ordering the second which was sustained.

But, to understand these questions, it is necessary to refer briefly to the evidence on the trial, and to the opinion of the court upon which the interlocutory decree was based.

1. There was a large amount of testimony introduced by the defendants, some of which is hereinafter referred to, which showed that there were several furnaces for burning wet tan in public use, and which the defendants had a right to use at the time of the alleged infringement, and that this use of other furnaces was in an economic and business sense successful.

2. It was shown, also, that these furnaces were in most particulars the equivalent of, if not identical with, the devices of the patentee; that the use of those devices, to the very limited extent they were used, was in good faith; that the device of the defendant was so nearly identical with the prior devices and furnaces so open to him that it was

almost or quite impossible to discriminate his own from the older ones; and that the addition of an element or part of the patented device to the older structures was in no sense (except as technically made so by applying the unwarranted theory of the referee) of any pecuniary or business advantage whatever.

3. The court in its opinion plainly declared the existence and utility of these old furnaces—antedating the plaintiff's invention—for burning wet tan successfully, and designated several of these by name. (See Record, bottom p. 154 and p. 155.)

It is true that it is stated the burning in them was said to be on different principles and in structures different from those of the patentee. But the fact is yet clear that the successful burning of wet tan was a public and established business and economy at the date of the invention.

(*a*) Great as was the weight of the testimony tending to show that the old furnaces and those of the patentee were identical, it is not proposed to attempt to reopen that question here.

It is enough that the court recognized—what the testimony abundantly proves—that there were in existence practical and successful methods of burning wet tan as a fuel in the very business and with the very results of which the patentee claimed a monopoly, and by methods, to all except nice experts, identical with the plaintiff's alleged invention.

(*b*) The evidence taken subsequently to the decree went still further, and showed that these old methods were in every respect as successful and economical as that alleged to have been invented by the patentee; in other words, that the inventions in dispute were without economical value or utility; the court so decided by its final order in

the case, and, therefore, declared that no profits had been made, and that there were none to be accounted for.

III.

It will be noticed that the judge mentions, as among the old furnaces in which wet tan was burned, the following, namely: the Crockett, the Morrison, the Woodstock, the Sparrowbush, and the Newark. (Record, p. 154 and p. 155.)

The following is some of the evidence, to the effect last cited, which was taken prior to the decree and upon which the statement in the opinion of the court was based:

1. Even the *plaintiff's witnesses, on the direct examination*, prove the successful burning of wet tan for five years in the Woodstock furnace; and more than this, for so effective was it that the plaintiff claims that the Woodstock furnace was made after his own device. (Record, p. 42 and p. 43, fol. 71 and 72.)

2. Similar proof and upon the same theory, though objected to by the defense, was made by the plaintiff's witness on the direct, in regard to the Crockett furnace, which is Exhibit 6. (Record, p. 46 and p. 47, fol. 80.)

(*a*) It was only after the plaintiff failed to prove these furnaces to be infringements that he tried to deprive the defense of the benefit of the evidence in regard to them.

(*b*) Exhibit No. 6, and also the drawings of the Woodstock, Newark and Sparrowbush furnaces, may be found in the Record between p. 140 and p. 141.

3. Similar proof was also made by the plaintiff in regard to the Sparrowbush and Morrison furnaces, though the effectiveness of those furnaces, as will be hereinafter shown, was grossly underrated. (Record, p. 91.) Yet on

cross-examination the plaintiff's witness admitted that the Sparrowbush burned wet tan of which 60 per cent. was water, and that the pretended dry tan used in that furnace really contained 15 per cent. of water. (Record, p. 94.)

(*a*) It will appear that no furnace made according to the patent could be used with so little dry fuel.

Defendant's Proofs on the Trial as to Effectiveness of the Earlier Furnaces.

1. The Woodstock is proved to have burned wet tan effectively for tanning and propelling machinery during five years at least, using no other fuel save in kindling a fire. (Record, p. 98 and p. 99.) The tan was so wet that water drained from it when put in the furnace. (Record, pp. 101, 110, and 111.) It burned "wet tan alone." (Record, p. 114, bottom.)

2. The defendants gave equally decisive testimony in regard to the Newark furnace, which was known as a Crockett furnace. After the fire was started nothing but wet tan was burned. (Record, p. 100 and p. 101.) It could be kept going a week without any dry fuel. (Record, p. 102 and p. 103, fol. 174.) Its success is declared perfect. (Record, p. 104, top.)

(*a*) There were many similar Crockett furnaces in public use before the plaintiff's invention. (Record, p. 105, fol. 177.) The practice of burning wet tan prevailed before 1852, and in numerous places. (Record, p. 106, fol. 178, and p. 139, fol. 235 and 236.)

3. The first Sparrowbush furnace burned wet tan in 1852, though a better one was built there for the purpose in 1853, three years before the plaintiff's invention. (Record, p. 108.)

4. A Morrison furnace is referred to, and its successful and exclusive burning of wet tan for a tannery of 20,000 hides a year and heating large buildings is described. (Record, p. 115, bottom, and p. 116 and p. 122.)

5. There was also another successful method of burning wet tan (besides those described and that of the plaintiff) which was in general use, and which many tanners preferred to either of the others. (Record, p. 130, fol. 236 and 237.)

IV.

Such was a part of the testimony before the court when the first reference was ordered to a master in July, 1872. He reported profits in favor of the plaintiff in the amount of $44,973.49. (Record, p. 160.)

The theory upon which this result was obtained appears plainly enough from the referee's report. (Record, p. 157 and 158.)

1. He made certain deductions for the dry wood which the plaintiff's own furnace would need to use for kindling fires; and it is important to bear in mind the amount of this deduction. (Record, p. 158, at top.)

2. He charged the defendants as profits the value of all the wood (besides such amount of kindling wood) which they would have used had they tanned all their hides by the use *of dry wood alone* (as distinguished from bark) as a fuel.

3. He therefore denied them the benefit of, or right of using, the practical and successful methods of burning wet tan which had, for years, been the free, public, well known usage and right of every tanner. This old method was in use near the tannery of the defendants, was well known to them, and they supposed they were using it. In other

words, the referee held that the utility of the plaintiff's invention, and his right of profits under it, were not to be measured by its economy and superiority when put in comparison with other means of utilizing wet tan as a fuel in free, notorious public use at the date of the invention, but that they were to be measured by comparing the invention with the usage and state of the art a generation earlier, when no wet tan was burned—thus excluding altogether the state of the art and the industry of the trade affected, at the time of the invention, and hence rejecting the very standards by which the novelty and utility of all inventions should be tested.

4. The true view of this decisive point is too clearly stated in the opinion of Judge Blatchford, (sustaining the defendant's exceptions, Record, p. 177 and p. 178, and ordering the report set aside,) to need further comment here. (Record, pp. 179 to 181.)

5. We have only to contrast the large amount allowed in the report as profits with the moderate sums charged, for licenses, by the inventor against tanners, doing quite as extensive business as the plaintiff, in order to see that the theory of the referee was as repugnant to the practical sense of justice as it is to legal principles. In no case had the inventor charged more than $150 for a general, unlimited license for the largest tannery. (Record, p. 33.)

(*a*) The theory of the referee and that of the patentee (moderated by his dealings with business men) stood in this ratio—$150 for a perpetual license as against one-third of $44,973.79 (there being three furnaces used by defendant) for about seven years' use.

V.

1. On the accounting other testimony for the defense was taken showing not merely, as on the trial, the successful

burning of wet tan alone, (save a very little wood for kindling,) but showing furnaces in every respect, to say the least, quite as economical and efficient as the inventor's own witnesses ever claimed his furnaces to be.

(*a*) The Sparrowbush furnace was also proved to be as effective as that of the plaintiff. (Record, p. 166, fol. 283.)

2. A furnace at Rochester, more extensive in the buildings heated than any other referred to in the evidence, is shown to have used only wet tan, save for kindling; and it is not pretended to have infringed. (Record, p. 319; see bottom page.)

3. A furnace at Milwaukee, built in 1851, not claimed to be within the patent, is equally effective. For three months together it used only wet tan for fuel *without dry fuel even for kindling.* There was more wet tan than was required, and the tannery did a vast business. (Record, p. 321.)

4. A furnace built in 1859 at Lehigh, Penn., burned wet tan alone, like the others, according to methods in use before the patent. It did not require kindling-wood even, more than three or four times a year, showing itself, therefore, like the last furnace referred to, to be more economical, in that regard, than even the referee found the patented device to be. (Record, p. 325.)

5. Still another furnace quite equal to anything claimed for that of the plaintiff's is described as in use at Wilcox, Penn., in 1857. It was only necessary to use wood in rebuilding the fires twice a year, being ten cords a year in all required. (Record, p. 326.)

(*a*) It is proved that at this tannery (page 326, bottom) 80,000 hides were tanned yearly, while requiring only 10

cords of wood in all. But the referee states that the plaintiff's furnace required 100 cords of wood for 15,000 hides, besides ten cords for starting fires! (Record, p. 158.)

6. After such overwhelming proofs of the superiority of furnaces in public use, and not claimed to be covered by the patent, it is hardly necessary to refer to evidence concerning one erected at Great Bend, Penn., in 1857, or to another built as far back as 1851, both of which burned wet tan successfully. (Record, pp. 328 and 330.)

The furnace at Great Bend perhaps surpassed all others in evidence, for it was run *two years without letting the wet-tan fire go out, and it took only ¼ of a cord of wood to start the fires anew.* It would tan 15,000 hides a year. (Record, p. 328, fol. 396.) But there was yet another non-infringing furnace which required only ¼ of a cord of dry fuel once in three months. (Record, p. 321.)

(*a*) The evidence on pages 330 and 331 of the record is interesting as showing that, after trial and failure, a furnace constructed according to the patentee's device and under direction of his agent failed, was taken down as useless, and that a successful furnace after the design of the non-infringing furnaces was erected in its place in 1866.

(*b*) Still other successful non-infringing furnaces only requiring kindling-wood twice a year are described on p. 334 of the record.

VI.

It was on the basis of this testimony that in his second report the referee declared that no profits were proved before him to have been made by the defendant through the use of the patented furnace. (Record, p. 183, bottom, and p. 184.)

This report may be sustained on several grounds:

1. The general superiority of the furnaces last described in the defendant's evidence upon every contested ground of economy *is not disputed by any testimony whatever. Indeed, the plaintiff did not so much as offer a single witness or document in refutation of that testimony*, which would alone abundantly sustain the report.

2. Inasmuch as no attempt was made to prove that the construction of the plaintiff's furnace was less expensive than the others, or that the labor needed in working it was any less than that required for working the older furnaces, there were left only two possible grounds of economy or profit by the defendant in the use of the patents, which were—

(1) That the patented furnace required the use of less kindling-wood than the others; but proof has already been cited which clearly shows the contrary; or,

(2) That the patented furnace would make equal heat by a consumption of a less amount of wet tan; but, aside from the absence of any proof or claim that a less amount of wet tan would suffice in the patented furnace, the evidence is abundant that wet tan had no value whatever except as such fuel to be burned at the tannery. Indeed the proof is that it tended to accumulate and to be in the way. Only at a tannery at Buffalo, and then in trifling quantities, had it ever been sold or had value. But among the hills of where the Thorndale, Albion, and La Porte furnaces were situated—being those alleged to infringe—wet tan had not the least value save as such fuel. It could not even be given away, nor all of it be used.

3. Besides, the plaintiff offered no testimony tending to show how much more dry fuel he thought the old furnaces

required than his own. Hence on his own theory of the law and his own construction of the patent, he could have no recovery.

4. And to that effect the court entered a final order sustaining the second report, which declared there were no profits, February 6, 1878. (Record, p. 340.)

First Point.

1. There is no claim made for license fees, nor is there any claim made for damages other than as they are represented by the pretended profits made by the defendants. No loss of sales of the patents is proved. The claim is solely for profits alleged to have been made by the defendants in the use of the invention.

2. The direction given by the court to the referee, (Record, p. 179,) which was in substance that the referee was to inquire and report what profits were made by the defendants by the use of the patent in question, and that, in deciding upon the basis of profits, the referee was to consider the advantages and results of the use of the furnaces for burning wet tan then commonly employed and open and free to the public and the defendants,—was in all respects correct.

No statement of profits could be made unless some other process or method of producing the heat was compared with that of the patentee. The most natural comparison was some different method of using the same kind of fuel, and using it in furnaces most nearly identical with that of the plaintiff. The furnaces compared were those before in use, so nearly like that of the patentee—if not identical with it—that only experts were able to discriminate them from his, and the differences were only in minute if not in merely trivial details.

It was proved that if he had invented anything new he had certainly invented nothing useful or profitable.

If the comparison made was not the true one, with what was the plaintiff's furnace to be compared? Was it to be with stoves? Was it to be with open fire-places? Or were we to go further back on the road of science and civilization and compare it with open-air log-fires in the woods for producing heat?

The fundamental conception of a patent is that of a process or structure which is both new and useful, not as compared with the art or practice in some past generation, but as compared with what is known and in use at the date of the invention.

The decisions abundantly sustain these views, and the only profits which the plaintiff can recover are such as he shall affirmatively prove the defendants to have made.

As there is no question concerning the relative quality of anything produced by using the patent—its production being heat alone—the sole issue is this, Did the patented invention produce the heat required by the three infringing furnaces more economically than would have been the case if no element or part of the plaintiff's patent had existed in those furnaces, or, in other words, more economically through saving something of value, than would have been the case had the old-fashioned furnaces, pure and simple, been used? If not, there were certainly no profits made by the use of the invention adjudged to have been infringed. And surely there can be no recovery of profits which were never made. It is only the profits actually made, and not those which might have been made, which can be recovered.

Dean *v.* Mason, 20 Howard R., 198.
Mowry *v.* Whitney, 14 Wallace R., 620, 651, 653.
Corporation, &c., *v.* Ransom, 23 Howard R., 487.
Seymour *v.* McCormick, 16 Howard R., 480, 489.
Packet Co. *v.* Sickels, 19 Wallace R., 618.
Littlefield *v.* Perry, 21 Wallace R., 205, 229.
Mason *v.* Wallace, 23 Wallace, 261.
Turrill *v.* Ills. Cen. R. R., 4 Bissell's C. C. Rep., 344.
American Nicolson Pavement Co. *v.* City of Elizabeth, Official Gazette U. S. Patent Office, vol. 6, p. 764.

SECOND POINT.

It follows that if the first point is sustained neither of the exceptions to the second report can be sustained. (See report, Record, p. 182 to 184.)

Opinion of judge on accounting, (Record, pp. 179 to 181.)

Exceptions to report, (Record, p. 338.)

1. The first exception is stated as if the part of the opinion referred to was the whole issue submitted, which is erroneous. It was properly made a material part of the inquiry. It was a part of the main question whether the plaintiff had invented anything useful, out of the use of which the plaintiff had made a profit.

2. The second exception needs no further notice.

3. The third exception is answered by the statement of Judge Blatchford in his original opinion on the hearing already cited. (Record, p. 154, bottom, and p. 155.)

4. The fourth exception has been sufficiently answered already.

5. The fifth exception is only another form of stating the fourth.

6. The answer to the sixth exception is that no competent testimony on the point referred to was excluded.

The decree of the court below, made on the sixth day of February, 1878, (Record, p. 340,) should, therefore, be affirmed, with costs to the appellees.

D. B. Eaton

Of Counsel for Appellees.